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Arizona Corporation Commission
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BEFORE THE ARIZONA CORPORATION COMMISSION

KRISTIN K. MAYES, Chairman
GARY PIERCE
PAUL NEWMAN
SANDRA D. KENNEDY
BOB STUMP

IN THE MATTER OF THE APPLICATION OF HUALAPAI VALLEY SOLAR LLC, IN CONFORMANCE WITH THE REQUIREMENTS OF ARIZONA REVISED STATUTES §§ 40-360.03 AND 40-360.06, FOR A CERTIFICATE OF ENVIRONMENTAL COMPATIBILITY AUTHORIZING CONSTRUCTION OF THE HVS PROJECT, A 340 MW PARABOLIC TROUGH CONCENTRATING SOLAR THERMAL GENERATING FACILITY AND AN ASSOCIATED GEN-TIE LINE INTERCONNECTING THE GENERATING FACILITY TO THE EXISTING MEAD-PHOENIX 500kV TRANSMISSION LINE, THE MEAD-LIBERTY 345kV TRANSMISSION LINE OR THE MOENKOPI-EL DORADO 500kV TRANSMISSION LINE.	Docket No. L-00000NN-09-0541-00151 Case No. 151 **NOTICE OF FILING LATE FILED EXHIBITS**

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2010 JUN 22 A 10: 34
AZ CORP COMMISSION
DOCKET CONTROL

Denise Bensusan, through her undersigned counsel, hereby provides notice that she has this day filed the exhibits attached to this Notice.

RESPECTFULLY SUBMITTED this 22nd day of June, 2010.

ARIZONA CENTER FOR LAW IN
THE PUBLIC INTEREST

By ______________________
Timothy M. Hogan
202 E. McDowell Rd., Suite 153
Phoenix, Arizona 85004
Attorneys for Denise Bensusan

ORIGINAL and 13 COPIES of
the foregoing filed this 22nd day
of June, 2010, with:

Docketing Supervisor
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Arizona Corporation Commission
1200 W. Washington
Phoenix, AZ 85007

COPIES of the foregoing
mailed this 22nd day of June,
2010 to:

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INDEX OF DOCUMENTS

1. Hydrology of Upper Colorado River Planning Area – Groundwater (West Basins); Arizona Department of Water Resources; http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/UpperColoradoRiver/PlanningAreaOverview/Hydrology.htm

2. Letter from Hualapai Nation to Federal Energy Regulatory Commission Re: Docket No. CP02-420-000, Proposed Red Lake Gas Storage Project; national Historic Preservation Act Section 106 Consultation – Written Request to be Consulting Party

3. Stirling Energy Systems Southwest Renewable Energy Conference September 19, 2009; SES Stirling Energy Systems

4. FPLE – Beacon Solar Energy Project Dry Cooling Evaluation FPLS-0-LI-450-0001 Rev B, February 1, 2008; Worley Parsons

5. City of Kingman Water Adequacy Study Final Report May 1993

DOCUMENT 1

Hydrology of the Upper Colorado River Planning Area - Groundwater (West Basins)

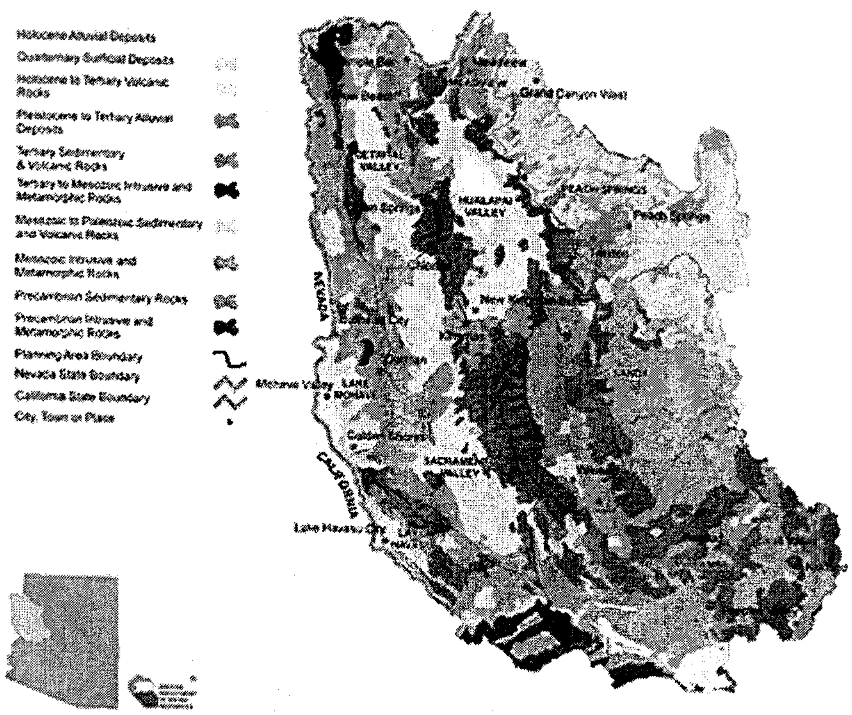


Figure 4.0-4 Surface Geology of the Upper Colorado River Planning Area

The Upper Colorado River Planning Area is characterized by semi-arid to arid alluvial basins with few perennial streams. Anderson, Freethey and Tucci (1992) divided the alluvial basins in south-central Arizona into categories based on similar hydrologic and geologic characteristics. These categories are useful in describing general hydrologic characteristics. Although their study area does not match the Department's groundwater basins exactly, the Upper Colorado River Planning Area is included in their study area with the exception of the Peach Springs Basin. Four basin categories identified by Anderson are represented in the planning area and are discussed below: **West**, **Colorado River**, **Highland** and **Southeast**.

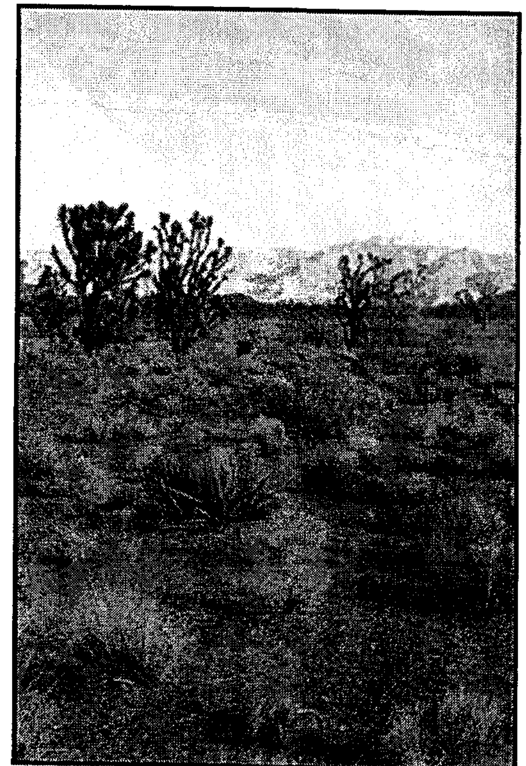
As shown in **Figure 4.0-4**, there are extensive outcrops of sedimentary and volcanic rocks of varying ages throughout the planning area. Large areas of basin-fill covered by alluvial and surficial deposits are found in the western part of the planning area, primarily in the West basins.

West Basins

The West basins include the **Detrital Valley**, **Hualapai Valley**, and **Meadview** basins, most of the **Sacramento Valley Basin** and part of the **Bill Williams Basin** (see **Figure 4.0-2**). Groundwater inflow and outflow are small and there is almost no stream baseflow. These basins contain extensive areas of basin fill deposits that comprise the primary groundwater bearing unit (aquifer).

Detrital Valley Basin

The Detrital Valley Basin is characterized by a relatively long valley whose floor slopes from 3,400 feet at the southern boundary to around 1,200 feet at Lake Mead. Groundwater occurs mostly in basin-fill material and in alluvial deposits along mountain washes. Intermediate and younger basin fill are above the water table in most areas, consequently the older basin fill aquifer is the primary water supply. In the northern part of the basin, the basin fill includes clastic (weathered) sediments, limestone, and basalt flows of the Muddy Creek and Chemehueve Formations. There are extensive evaporate deposits in the older alluvium in the northern part of the basin (Anning and others, 2007). Depth to bedrock may exceed 6,000 feet at the deepest point. A clay unit may extend from 600 to 1,400 feet below land surface (bls) in the central portions of the basin, which acts as an impediment to groundwater flow and reduces the amount of recoverable groundwater due to its low specific yield. The areal extent of this unit is not well known due to lack of data (Mason and others, 2007). Groundwater flow direction is north toward Lake Mead. At the northern end of Detrital Valley water from Lake Mead infiltrates to the basin-fill aquifer and near by groundwater levels fluctuate with the levels. Depth to water may be less than 100 feet bls in this area (Anning and others, 2007).


Detrital Valley Basin. The estimated volume of recoverable groundwater to a depth of 1,200 feet bls ranges from about 1.48 to 3.94 maf.

Groundwater recharge is estimated at 1,000 AFA. Groundwater discharge is to springs and from relatively small well withdrawals for municipal purposes. The volume of recoverable groundwater to a depth of 1,200 feet bls is estimated to range from about 1.48 to 3.94 maf (Mason and others, 2007). The median well yield in measured wells is generally 35 gpm or less (**Table 4.3-5**). As shown in **Figure 4.3-6**, groundwater levels were relatively stable in wells measured in 1990-91 and 2003-04, although water-level measurements for different time periods show long-term declines in an area northeast of Dolan Springs (Anning and others, 2007). Water quality is suitable for most purposes although concentrations of radionuclides and arsenic that exceed drinking water standards have been measured at wells throughout the basin. (**Table 4.3-6**, **Figure 4.3-9**).

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Hualapai Valley Basin

The Hualapai Valley Basin trends north-northwest and is about 60 miles long, stretching from the Hualapai Mountains to Lake Mead. The basin has relatively deep, sediments divided into three units. The younger basin fill includes recent streambed deposits in Hualapai Valley and alluvium along mountain canyons. This unit yields relatively small volumes of water to stock and domestic wells. The intermediate basin fill, which is composed of coarse-grained sands, silts and clays, is a dependable aquifer only along the valley margins where the unit intersects the water table. As with other basins in this category, the older basin fill is the primary water supply. Similar to the Detrital Valley Basin located to the west, older basin fill in the northern part of the valley includes clastic sediments, limestone and basalt flows of the Muddy Creek and Chemehueve Formations. Volcanic rocks are interbedded with the older basin fill in the southern part of the basin and yield water for municipal and domestic purposes. Groundwater flows into the central part of the basin from the south and along Truxton Wash near Hackberry (**Figure 4.4-6**). Surface water collects in the Red Lake playa bear the center of the basin, whereas groundwater flows to the north underneath the topographic divide near Pierce Ferry Road (Anning and others, 2007).

Groundwater recharge comes primarily from streambed infiltration and is estimated at 2,000 to 3,000 AFA (**Table 4.4-4**). Groundwater discharge is to several major springs and from relatively large volumes of well pumpage for municipal use by Kingman. The well pumpage is are almost three times the estimated groundwater recharge rate. Groundwater in storage estimates range widely from 3 to 21 maf. Median reported well yields are relatively high at 900 gpm (**Table 4.4-4**). In the central and northern part of the basin groundwater levels were relatively stable or rising between 1990-91 and 2003-04 while water levels were declining in the southern part of the basin (**Figure 4.4-6**). Water-level measurements over longer time periods show fluctuating water levels in the basin with long-term declines found in the area northwest of Hackberry (Anning and others, 2007). Groundwater is highly mineralized in some areas near the mountains and near Red Lake. Chromium has been detected in some wells in the basin.

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Meadview Basin

The relatively small Meadview Basin is characterized by a valley formed by Grapevine Wash in the north, and a highland area, Grapevine Mesa in the south. The basin floor slopes toward Lake Mead from an elevation of about 4,400 feet to 1,400 feet. The main aquifer occurs in the Muddy Creek Formation which contains three units. The upper limestone unit yields water to springs and shallow wells. The middle sandstone unit has a high clay content that limits its ability to transmit water. The lower unit is a conglomerate with high hydraulic conductivity. Most well development has been in this lower unit. Groundwater flow is from south to north, following Grapevine Wash.

Groundwater recharge is relatively small, about 4,000 AFA, due to low rainfall and high evaporation rates. Groundwater discharge is to springs and a relatively small volume of municipal well pumpage. Groundwater in storage is estimated at 1.0 maf or less. The median measured well yield is 33 gpm (**Table 4.7-5**). There is little water level monitoring in the basin. Available data show water levels as deep as 931 feet bls in the southern part of the basin and declines of more than 15 feet have been measured in a well in the vicinity of Meadview during the period 1990-91 and 2003-04 (**Figure 4.7-6**). Groundwater quality is generally good in the basin, with elevated concentrations of radionuclides measured primarily in or near granitic areas (ADEQ, 2005).

Colorado River, Sacramento Valley Basin. Groundwater recharge is from infiltration of runoff in washes and along mountain fronts,

Sacramento Valley Basin

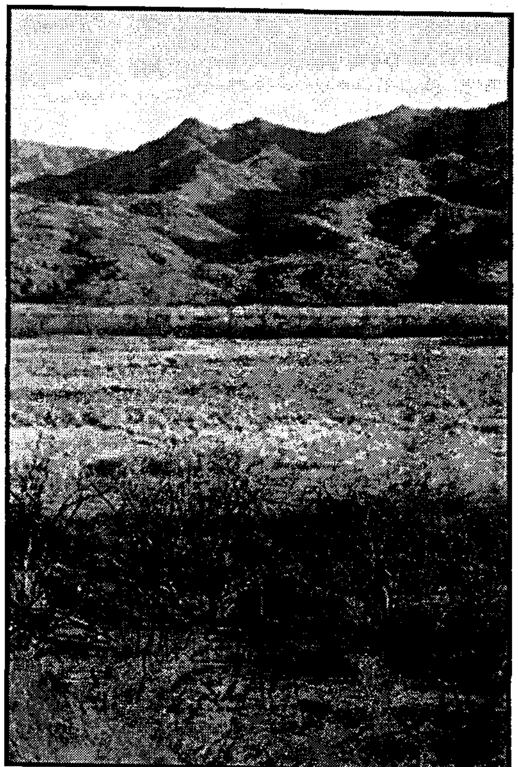
Sloping alluvial fans extend from surrounding mountains to the north-south trending valley floor of the Sacramento Valley Basin. The valley floor generally slopes to the south with elevation ranging from more than 8,400 feet at Hualapai Peak to about 500 feet where Sacramento Wash enters the Colorado River. Older basin fill is the principal aquifer in the basin. There are fractured and faulted volcanic rocks in the vicinity of Kingman that separate this basin from the Hualapai Valley Basin. Water stored in the fractures is except in the vicinity of the Colorado River where infiltration of river water is the main source of recharge.

used as part of the municipal water supply for Kingman and for domestic wells. The fractured granite aquifer beneath the community of Chloride is insufficient to meet its needs and water must be hauled from Kingman. Groundwater flow is toward the center of the Sacramento Valley and west to the Colorado River.

Groundwater recharge is from infiltration of runoff in washes and along mountain fronts, except in the vicinity of the Colorado River where infiltration of river water is the main source of recharge. Groundwater recharge is estimated at 1,000 to 4,000 AFA. Groundwater discharge is to a number of springs and from municipal and industrial well pumpage. Groundwater in storage estimates range from 7 to 14 maf. Recent investigations using a range of specific yield values estimated 3.6 to 9.5 maf of groundwater in storage to a depth of 1,200 feet bls (Conway and Ivanich, 2008). Median well yields are between 100 and about 170 gpm (**Table 4.9-6**). Groundwater levels may be relatively deep with depths greater than 500 feet measured at several locations. Water levels declined in measured wells in the vicinity of Kingman and east of Topock between 1990-91 and 2003-04 (**Figure 4.9-6**). Water-level measurements over longer time periods show fluctuating water levels in the basin with long-term declines in the Kingman area and Golden Valley area (Anning and others, 2007).

Groundwater quality is generally good in the basin except along the base of the mountains where waters of high mineral content are common. A study conducted by ADEQ found water quality exceedences in the majority of sample sites in three areas: near the town of Chloride; in the central and southern Hualapai Mountains; and near the town of Topock (ADEQ, 1999). Concentrations of radionuclides in Chloride town wells have exceeded Safe Drinking Water Act maximum contaminant levels (City of Kingman, 2003).

Top



Bill Williams River, Bill Williams Basin. Well Yields may exceed 2,000 gpm along the Bill Williams River.

Bill Williams Basin (western portion)

Anderson, Freethey and Tucci (1992) categorized most of the western portion of the Bill Williams Basin as a "West" basin, which generally corresponds to the Alamo Reservoir and Clara Peak sub-basins (see **Figure 4.2-6**). The area in the vicinity of the Colorado River is influenced by infiltration of river water. Groundwater in the western part of the basin occurs primarily in recent stream alluvium and basin fill. The water-bearing ability of these units varies within the basin. The stream alluvium consists of gravel, sand and silt along the Bill Williams River and its major tributaries. The main water-bearing unit is the basin fill, which is more than 5,000 feet thick in the Bullard Wash-Date Creek Area southeast of Alamo Lake State Park. Groundwater flow is toward the Bill Williams drainage.

Groundwater recharge is from streamflow and mountain front precipitation and is estimated at 32,000 AFA for the entire basin. From 10 to 23 maf of groundwater is estimated in storage. There is little groundwater development in the western portion of the basin and relatively little groundwater level data (see **Figure 4.2-6**). Available water level data show stable water levels. Well yields may exceed 2,000 gpm along the Bill Williams River. Arsenic and fluoride concentrations that exceed drinking water standards have been reported from this portion of the basin as well as elevated levels of cadmium near the mouth of the Bill Williams River.

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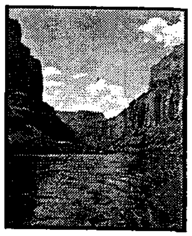
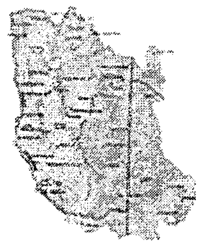
For more information on Groundwater in individual basins in the Upper Colorado River Planning Area see the menu to the right

Click here to continue to the next Section 4.0.2 Hydrology - Groundwater (Colorado River Basins)
or **click here to skip ahead to Section 4.0.2 Hydrology - Surface Water**

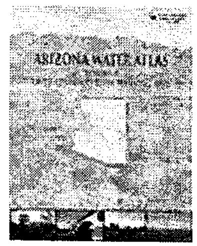
Arizona Water Atlas Home



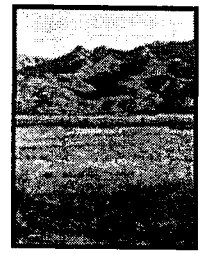
Upper Colorado River Planning Area Home



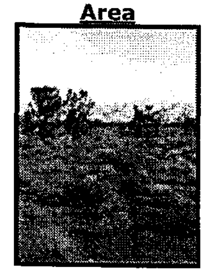
Download pdf of entire Upper Colorado River Planning Area



Download pdf of the Upper Colorado River Planning Area Overview



References and Suggested Reading for the Upper Colorado River Planning Area



DOCUMENT 2

The Great Spirit created Man and Woman in his own image. In doing so, both were created as equals. Both depending on each other in order to survive. Great respect was shown for each other; in doing so, happiness and contentment was achieved then, as it should be now.

The connecting of the Hair makes them one person; for happiness or contentment cannot be achieved without each other.

The Canyons are represented by the purples in the middle ground, where the people were created. These canyons are Sacred, and should be so treated at all times.

The Reservation is pictured to represent the land that is ours, treat it well.

GREAT SEAL OF HUALAPAI TRIBE 1883 PEACH SPRINGS, ARIZONA

The Reservation is our heritage and the heritage of our children yet unborn. Be good to our land and it will continue to be good to us.

The Sun is the symbol of life, without it nothing is possible – plants don't grow – there will be no life – nothing. The Sun also represents the dawn of the Hualapai people. Through hard work, determination and education, everything is possible and we are assured bigger and brighter days ahead.

The Tracks in the middle represent the coyote and other animals which were here before us.

The Green around the symbol are pine trees, representing our name Hualapai – PEOPLE OF THE TALL PINES –

HUALAPAI NATION
OFFICE OF THE CHAIRWOMAN

Louise Benson
Chairwoman

P.O. Box 179 • Peach Springs, Arizona 86434 • (520) 769-2216

Carrie Imus
Vice Chairwoman

March 27, 2003

Magalie R. Salas, Secretary
Federal Energy Regulatory Commission
888 First St., N.E., room 1A
Washington, D.C. 20426

TRIBES OPPOSITION EXACT SAME LAND AS HVS

RE: Docket No. CP02-420-000, Proposed Red Lake Gas Storage Project; National Historic Preservation Act section 106 consultation – Written request to be a consulting party.

Dear Secretary Salas,

The purpose of this letter is to provide written notice to the Federal Energy Regulatory Commission (herein "FERC" or "the Commission") that ***the Hualapai Nation hereby requests to be a consulting party for the review of this proposed project pursuant to section 106 of the National Historic Preservation Act (NHPA).*** 16 U.S.C. §470f. As a federally recognized Indian tribe, the Hualapai Nation makes this written request pursuant to section 101(d)(6) of the statute, 16 U.S.C. §470a(d)(6), and the regulations issued by the Advisory Council on Historic Preservation, particularly 36 C.F.R. §§800.2(c)(2)(ii) and 800.3(f)(2). The statutory language in NHPA section 101(d)(6) provides that places "of religious and cultural importance to an Indian tribe" may be eligible for the National Register of Historic Places, and:

> "In carrying out its responsibilities under section 106, a Federal agency shall consult with any Indian tribe or Native Hawaiian organization that attaches religious and cultural significance to [historic properties that may be affected by a federal or federally assisted undertaking]."

This requirement of NHPA section 101(d)(6) applies regardless of the location of the historic property at issue, i.e., regardless of whether or not such a property is within the boundaries of a tribe's reservation. This requirement has been implemented through regulations issued by the Advisory Council on Historic Preservation (herein "ACHP" or "Advisory Council") governing the section 106 process. 36 C.F.R. part 800. The specific sections cited above, §§800.2(c)(2)(ii) and 800.3(f)(2), provide that the federal agency with authority over a federal or federally assisted undertaking must make a reasonable and good faith effort to identify tribes that attach religious and cultural significance to historic properties that may be affected by the proposed undertaking and invite them to be consulting parties.

Section 800.3(f)(2) expressly provides that any such tribe "that requests in writing to be a consulting party shall be one." Accordingly, the Hualapai Nation formally requests to a consulting party for the review of proposed project pursuant to the NHPA section 106 process. The Hualapai Tribal Historic Preservation Officer (THPO), Ms. Loretta Jackson, will serve as the primary contact for the Hualapai Nation for this consultation. She can be reached at (928) 769-2223.

The proposed Red Lake project would be located on Hualapai tribal ancestral lands as identified in the 1950's from Hualapai Land Claims Studies and recognized in a final decision of the Indian Claims Commission. The Hualapai Nation inhabited the area where the proposed Red Lake project would be located from time immemorial until the establishment of our current Reservation by Executive Order in 1883. Members of the Hualapai Nation have continued to use that area for religious and cultural purposes, and sites on nearby federal land administered by the Bureau of Land Management. Moreover, Red Lake is an important site in the oral tradition of our Nation.

Accordingly, we must inform the Commission that the proposed Red Lake natural gas storage project would cause adverse effects on a property that the Hualapai Tribe regards as holding great religious and cultural importance. As a tribe that has established a tribal historic preservation program that has been approved by the National Park Service pursuant to section 101(d)(2) of the NHPA, 16 U.S.C. §470a(d)(2), the Hualapai Nation has extensive experience in the application of the criteria of eligibility for the National Register of Historic Places. Our THPO believes that the property of religious and cultural importance to the Nation that would be affected by the proposed Red Lake project is eligible for the National Register of Historic Places, and that application of the National Register criteria by FERC and the Arizona State Historic Preservation Officer (AZ SHPO) in carrying out the section 106 process, with the Hualapai Nation as a consulting party, will result in such a determination of eligibility. We have been in communication with the AZ SHPO to inform that office of our concerns regarding this proposed project, and we have been advised that, from the perspective of AZ SHPO, the section 106 process for this proposed project has not yet commenced. We are providing the AZ SHPO and the Advisory Council each with a copy of this letter.

Red Lake is a kind of historic property often referred to as a "traditional cultural property" ("TCP"). Although the statutory duty to consult with tribes regarding historic properties that hold religious and cultural significance was enacted in the NHPA Amendments of 1992, TCPs have long been recognized as a kind of property that is potentially eligible for the National Register. The National Park Service has issued a guidance document on TCPs, National Register Bulletin 38, Guidelines for Evaluating and Documenting Traditional Cultural Properties (herein "Bulletin 38"). Bulletin 38 explains that a TCP need not include any physical evidence of human activity: "Construction by human beings is a necessary attribute of buildings and structures, but districts, sites and objects do not have to be products of, or contain, the work of human beings in order to be classified as properties. ... A natural object such as a tree or a rock outcrop may be an eligible object if it is associated with a significant tradition or use." With respect to the "integrity" of a TCP, Bulletin 38 says, "The integrity of a possible traditional cultural property must be considered with reference to the views of traditional practitioners; if its integrity has not been lost in their eyes, it probably has sufficient integrity to justify further evaluation."

A possible reason that FERC, as of this date, has not begun to fulfill its statutory obligations to consult with the Hualapai Tribe is that FERC's regulations addressing compliance with NHPA section 106 apparently fail to acknowledge FERC's statutory duty to consult with tribes regarding historic properties of religious and cultural importance outside of current reservation boundaries. For example, 18 C.F.R. Part 157, Appendix 2 to Subpart F, acknowledges that for undertakings affecting tribal lands a Tribal Historic Preservation Officer (THPO) may need to be consulted instead of the State historic Preservation Officer (SHPO), but makes no mention of the statutory right of tribes to be included in the Section 106 consultation process regarding historic properties (including TCPs) outside of tribal lands, nor of the FERC's statutory duty to honor this right. The FERC regulations at 18 C.F.R. §380.14 are similarly flawed. FERC's regulations do at least acknowledge, however, that the requirements of NHPA Section 106 do apply to FERC. 18 C.F.R. §380.14(a). Unfortunately, the FERC regulations simply overlook the statutory obligations to consult with tribes.

In addition, FERC's recently issued staff guidance document, "Guidelines for Reporting on Cultural Resources Investigations for Pipeline Projects" (Office of Energy Projects, December 2002), similarly ignores the statutory rights of tribes such as the Hualapai Nation to be consulting parties when federal or federally assisted undertaking may affect historic properties outside of reservation boundaries that hold religious and cultural importance for a tribe. Examples of the deficiencies of this guidance document are found at several points, including Section IV.B, which says that the "project sponsor or its consultant *should* also conduct independent research into which Indian tribes historically used the project area and request the comments of those tribes regardless of where the tribes currently reside." (Emphasis added.) The document provides no guidance regarding the statutory right of a tribe to be a consulting party. Another major legal deficiency is found in the definition of "Appropriate parties" in section XII, which includes this clause: "... and Indian tribes who own or manage land within the APE [area of potential effects]." As noted earlier, the statutory right to be a consulting party is *not* conditioned on the ownership or management of land. Similarly, the definition of "Indian tribe" includes the sentence: "Indian tribes which do not own or manage land within the APE would also be involved as interested persons." This ignores the statutory right of tribes to be consulting parties. We realize that the cultural resources report for the proposed Red Lake project (Exhibit F-1, Resource Report 4, Cultural Resources (June 2002)) must have been prepared before the December 2002 guidance document was issued, but whatever guidance was provided to the applicant at that time must have been similarly flawed. (We have been advised by staff of the consulting firm that prepared this report that they understood FERC to be exempt from the NHPA section 106 process.)

As an apparent consequence of its flawed regulations and guidance document, FERC has not yet begun to fulfill its duties to consult with the Hualapai Nation to avoid adverse effects to Hualapai traditional cultural properties on Hualapai tribal ancestral lands. In addition to the known TCP that would be affected by this proposed project, the Hualalpai Tribe is also concerned that tribal sacred sites on land managed by the Bureau of Land Management (BLM) would be adversely affected. Pursuant to Executive Order 13007, Indian Sacred Sites (May 24, 1996; 61 Fed. Reg. 26771), BLM has been charged with managing these sites to accommodate access to such sites for ceremonial uses and to avoid adverse impacts. The Hualapai Nation is also concerned that the off-reservation environmental impacts may result in impacts on TCPs and sacred sites that are located within tribal lands.

We note that the December 2002 FERC staff guidance document, in section IV.B.2, indicates that, if a tribe informs the project sponsor that the tribe wishes to consult directly with the FERC, the project sponsor should notify the FERC Office of Energy Projects (OEP) and OEP staff will consult directly with the tribe. This is generally consistent with the provision in the Advisory Council regulations stating that an agency may authorize an applicant to initiate consultation, but that the agency official "remains legally responsible for all findings and determinations charged to the agency official" and that "Federal agencies that provide authorization to applicants remain responsible for their government-to-government relationships with Indian tribes." 36 C.F.R. §800.2(c)(4). It is unfortunate that the project sponsor in this case failed to inform the Hualapai Nation of this option, and that we have no choice but to invoke this option at this time.

Accordingly, as a consulting party in the Section 106 process for this proposed project, we formally request FERC's Office of Energy Projects to engage in consultation with Hualapai THPO beginning with the identification of historic properties pursuant to the Advisory Council's regulations 36 C.F.R. §800.4. FERC cannot assume without consultation with the Hualapai Tribe that the proposed undertaking "is without the potential to effect" historic properties that the Hualapai Tribe considers to be TCPs. By these comments, the Hualapai Tribe and Hualapai THPO place the FERC on notice that Hualapai TCPs and sacred sites outside of Hualapai tribal lands may be adversely affected by the proposed undertaking, and thus FERC must consult with the Hualapai Tribe in compliance with NHPA section 106 and the Advisory Council's regulations. We must begin with the identification step before we can move on to assessing adverse effects under section 800.5 and resolution of adverse effects under section 800.6.

By copy of this letter, we also request that the Arizona SHPO engage in this consultation, and by copy of this letter we are informing the Advisory Council on Historic Preservation of the status of the review of this proposed project.

Decision to Prepare an Environmental Impact Statement (EIS)

The Hualapai Nation appreciates the decision by FERC staff to require the preparation of an environmental impact statement (EIS) for this proposed project, rather than to rely on an environmental assessment (EA) and finding of no significant impact for compliance with the National Environmental Policy Act (NEPA). The Hualapai Nation has decided not to seek cooperating agency status for the preparation of this EIS. We believe that our concerns can be addressed through the NPHA section 106 process. We note that NHPA section 106 and NEPA are separate and distinct requirements of federal law.

Potential Conflict with FERC Rules on "Off-the-Record" Communications

On November 13, 2002, the Hualapai Nation filed a motion to intervene in this proceeding. On January 30, 2003, in its "Preliminary Determination of Non-Environmental Issues," FERC granted the Hualapai Nation's motion to intervene. As we understand the Commission's procedures, only interveners have the right to seek a rehearing of the Commission's decision and to otherwise seek review of such a decision. Based on our understanding of the proposed project, we do not believe that it can be constructed without causing serious adverse effects to historic properties that hold great religious and cultural importance for the Hualapai Nation. Accordingly, the Hualapai Nation must anticipate the possible need to seek review of the ultimate decision on this application, and therefore the Hualapai Nation believes that it must maintain its status as an intervener.

EXACT SAME LAND AS HVS

We have been informed by FERC staff that, while the Commission's staff would prefer for the Hualapai Nation to participate in the environmental review required by NEPA as a cooperating agency, the Nation would have to withdraw its motion to intervene. The rationale we were given is that participation of an intervener as a cooperating agency would be contrary to the Commission's rules on "off-the-record" (or "*ex parte*") communications. While the Nation has decided not to seek cooperating agency status, we anticipate that the Commission's staff may raise the same objection to consultation with the Nation pursuant to the NHPA section 106 process.

To Christine Lee

As we understand the FERC regulations on "off-the-record" communications, 18 C.F.R. part 385, subpart V (section 385.2201), these regulations are intended to implement the provisions of the federal Administrative Procedure Act (APA) that prohibit off-the-record communications in administrative adjudication between an "interested person" and an official or employee of the agency who is involved in the

TRIBES OPPOSITION

decision-making process. 5 U.S.C. §557(d). The issuance of certificates public convenience and necessity for projects such as the proposed Red Lake project are subject to administrative adjudication pursuant to the APA, and the Commission interprets "interested person" to include a person that has been granted intervener status. The introductory clause of APA subsection 557(d)(1), however, expressly provides that the prohibitions set out in that section do not apply "to the extent required for the disposition of ex parte matters as authorized by law ..." Consultation with Indian tribes as part of the NHPA section 106 process is required by law, specifically, by NHPA section 101(d)(6), as quoted earlier. Accordingly, we believe that the prohibitions set out the remainder of APA section 557(d) do not apply to NHPA section 106 consultation with tribes.

We note that the FERC regulations incorporate the introductory clause of APA subsection 557(d), but modify by adding that the prohibitions do not apply to "An off-the-record communication permitted by law *and authorized by the Commission*; ..." 18 C.F.R. §385.2201(e) (emphasis added). Unfortunately, the Commission has not amended its regulations to explicitly authorize off-the-record NHPA section 106 consultation with a tribe that is also an intervener. This, however, does not relieve the Commission of its statutory obligation to consult with the Hualapai Nation in this matter. We suggest that the Commission must find a way to fulfill its statutory obligation to consult with the Hualapai Nation, even if that means that the Commission must amend its regulations. One alternative would be for the Commission's staff to negotiate an agreement among all the parties, as provided in 18 C.F.R. §385.2201(e)(iii).

In any event, the Hualapai Nation asserts our right to be consulted as part of the section 106 process, and we decline at this time to withdraw out motion to intervene, as we need to preserve our right to seek rehearing and review of this project in the event that the Commission does ultimately authorize the applicant to construct and operate the project in a way that causes harm to one or more historic properties that hold religious and cultural significance for us. We are willing to meet with the Commission's staff to discuss ways to resolve this apparent conflict between the Commission's regulations and its statutory duty to consult with our Nation. We do not believe, however, that the Commission's rules on off-the-record communication can be allowed to override the Commission's statutory obligation to consult with our Nation.

Respectfully submitted,

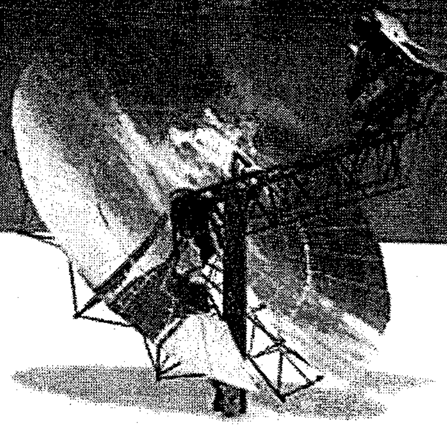
Louise Benson

Louise Benson, Chairwoman
Hualapai Nation

Cc: Mr. James Garrison
Arizona State Historic Preservation Officer
State Historic Preservation Office
1300 W. Washington St.
Phoenix, AZ 85007
Attn: Matthew Bilsbarrow

Ms. Carol Gleichman, Program Analyst
Advisory Council on Historic Preservation
12136 W. Bayaud Ave. Suite 330
Lakewood, CO 80228

DOCUMENT 3



SES Stirling Energy Systems

Stirling Energy Systems

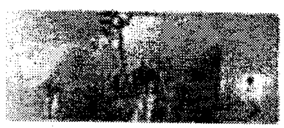
Southwest Renewable Energy Conference

September 10, 2009

History of SES

1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2009

Formed 1996 in Phoenix, SES acquires dish system technology previously developed by McDonnell Douglas, Southern California Edison, the Dept. of Energy and Sandia National Laboratories



Focus on developing and commercialising the SunCatcher technology for solar thermal applications

Signs Power Purchase Agreements with each of San Diego Gas & Electric (900 MW) and Southern California Edison (850 MW)

May '08 - NTR plc (renewable energy operator and developer) completes a $100m investment in May to take a controlling interest in SES

- Integration well underway - headcount triples in first six months
- 2 x AFCs submissions (key permitting filing in CA) filed with the CEC

In May 2008, NTR plc invested $100 Million to acquire controlling interest in SES

NTR History

Pre 1999 Toll Road Pioneer		1999 - 2002 Irish Diversification		2002 - 2006 Int'l Development		2007 - 2008 Transition	
EAST-LINK	1984	greenstar	1999	greenstar	UK 2003 US 2006	WEST-LINK	Sale & monetisation $780m
WEST-LINK	1990	Airtricity	1999	Airtricity	UK 2002 US 2004	Airtricity	Sale of NA & European businesses $2.8bn
		celtic anglian water	2001	Bioverda	Germany 2006 US 2007	Bioverda	Withdrawal from Germany
		Irish broadband	2002			Irish broadband	Merged with Imagine
						Wind Capital Group	Acquired 2008
						SES	Acquired 2008
						GPRE	Acquired 2008

NTR Today

SOLAR North America International	SES, Tessera Solar
WIND North America	Wind Capital Group
ETHANOL North America	GPRE
RECYCLING *Ireland UK North America*	greenstar

Highly Experienced Developer, Financier and Operator of Renewable Energy and Sustainable Waste Management.

SES Business Model

Tessera Solar

- Origination
- Engineering
- Procurement (non OEM)
- Project Finance
- Construct Site BOP
- Plant Operations
- Power Supply Scheduling
- BOP Maintenance

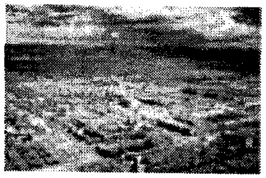
SES

- SunCatcher Materials
- Logistics
- SunCatcher Site Assembly / Installation
- SunCatcher Start up
- O&M

SES Inc's role is to manufacturer, deliver and assemble/install SunCatcher equipment and provide O&M Services post COD

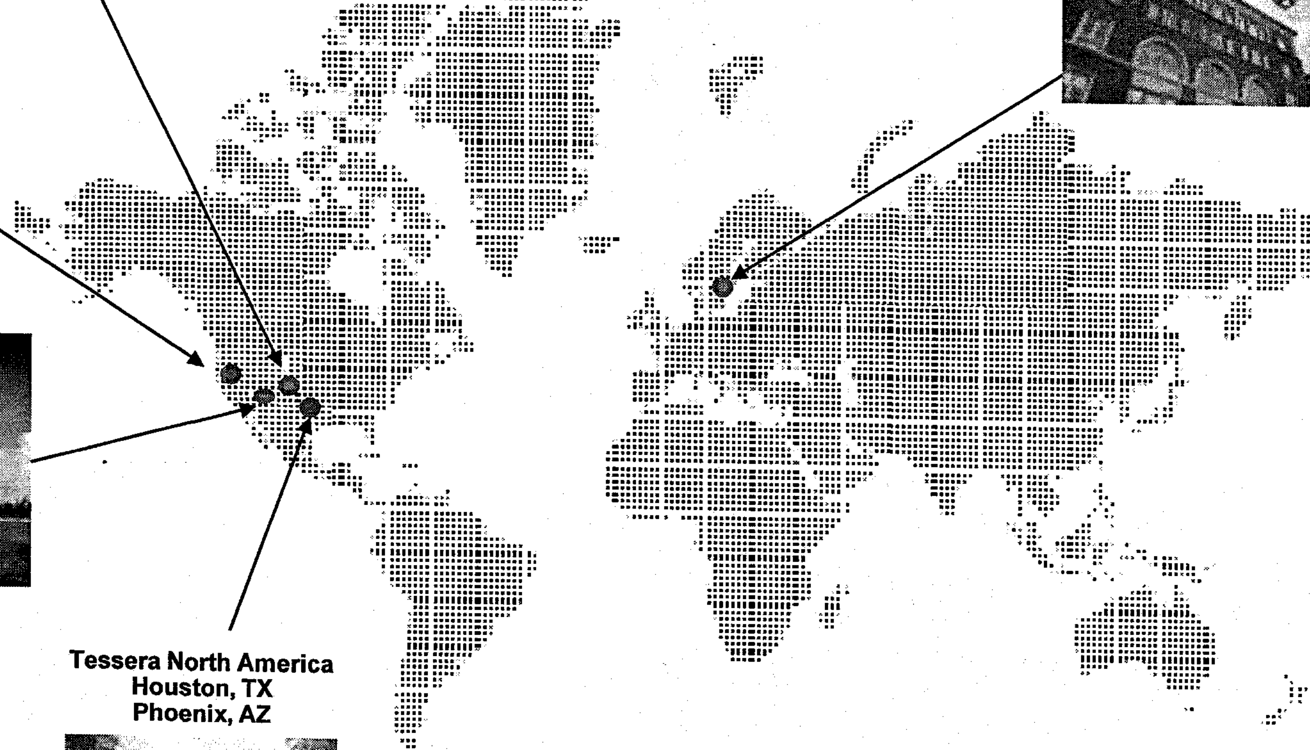
Organization

Sandia National Labs
Albuquerque, New Mexico

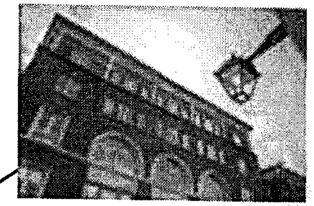


Tessera/SES Office
Berkeley, CA, USA

SES Corporate Headquarters
Scottsdale, Arizona, USA



International Development
London, UK

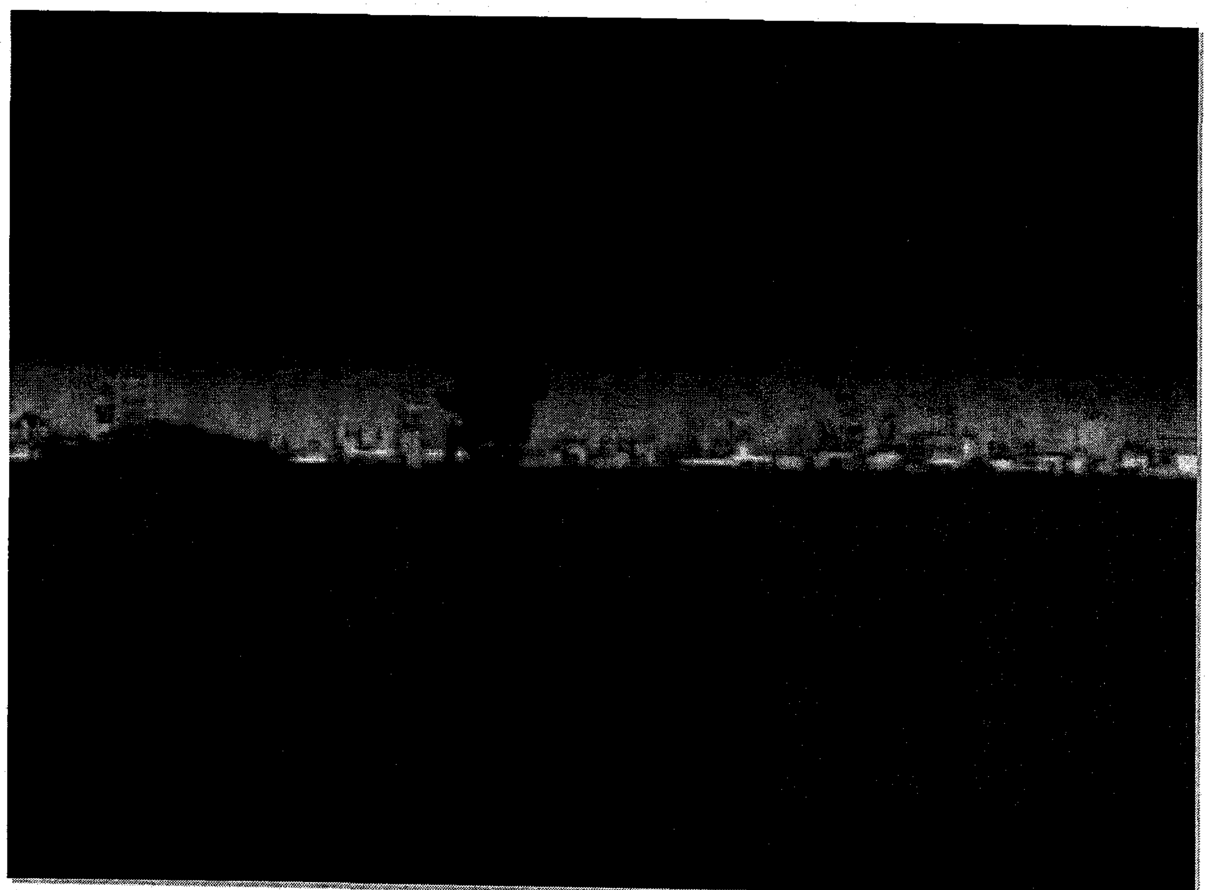


Tessera North America
Houston, TX
Phoenix, AZ

Solar Dish Stirling Engine

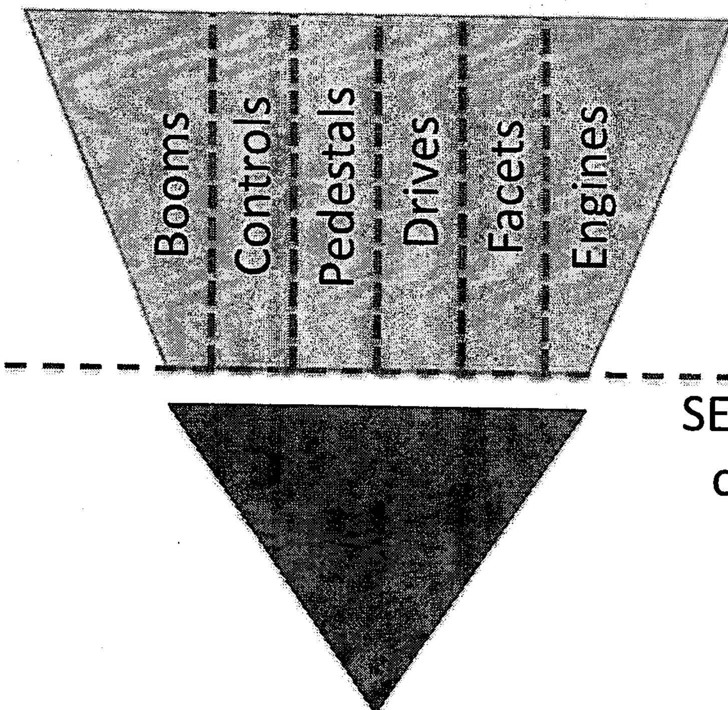
- Dish Concentrator Focuses Sun's Energy on Receiver
- Stirling Engine Converts Thermal Energy to Electrical Energy

Click image to advance animation

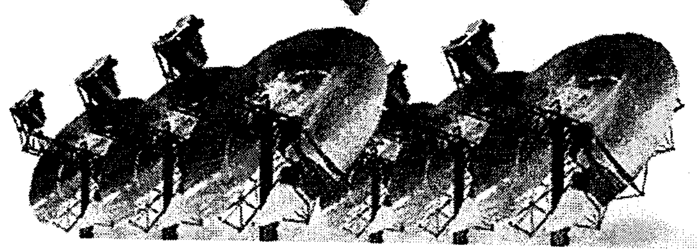


SES Utilizes the Integration Model

Suppliers design and engineer the SunCatcher's components

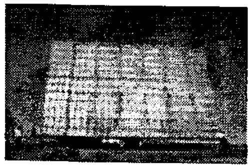
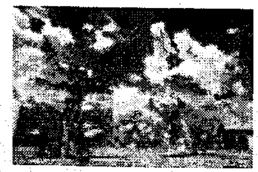
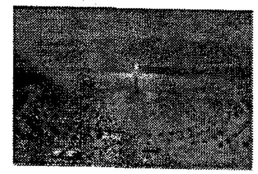


SES integrates the components to assemble SunCatchers



By integrating components sourced from strategic partners in the automotive and aerospace industries, SES is able to achieve rapid and scalable production

Solar Technology Landscape

	Photovoltaic		Solar Thermal			
	Traditional PV	CPV	Dish Engine	Trough	Tower	Fresnel Reflector
						
Technology Overview	PV cells (usually silicon based) convert solar energy directly into electrical energy	Mirrors or lenses focus sunlight onto highly efficient (multi-junction) PV cell	Receiving dish made of curved mirrors focuses sunlight onto Stirling Engine	Rows of trough shaped mirrors direct concentrated radiation onto receiver tube	Sun tracking mirrors focus sunlight onto a central receiver (usually tower mounted)	Similar to trough but uses flat (Fresnel) mirrors to concentrate light
Optimal Project Sizes	<10kW to 10mW	100kW to 100mW	100kW to >100mW	50mW to >100mW	50mW to >100mW	50mW to >100mW

Dish Engine Systems enjoy highest efficiency(up to 30%) and are among the most versatile

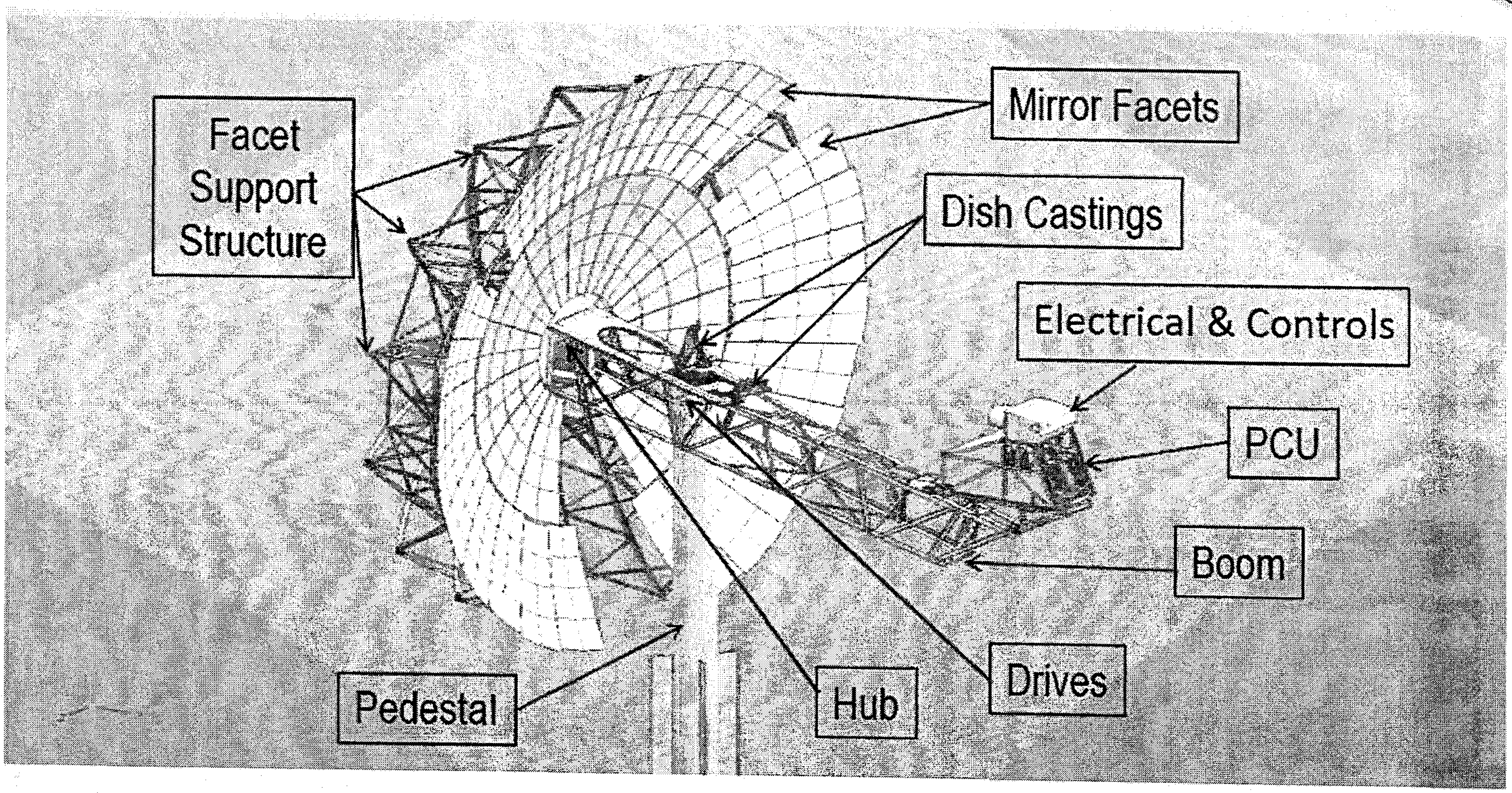
SunCatcher™

- 25 kW solar power system
- Dish concentrator tracks, collects, and focuses the Sun's energy
- Stirling engine converts thermal energy to grid quality electricity.

- Highest efficiency among peers (avg. ~25%, record at 31%)
- Minimal water requirement (4.5 gallons/MWh)
- Dish systems both modular & scalable
- Terrain flexible (<5% grade)
- Caters to utility & distributed models

In one year, a 750 MW SunCatcherr™ System's water usage will be equivalent to that of 33 Average Californian Households

The Dish



High Volume Production Model incorporates changes to be Lighter, Stiffer, and Optically Superior

Advantages & Innovations

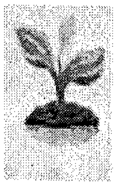
- ***Innovative Technology*** → Highest efficiency means more power from same area, utilizing all available land

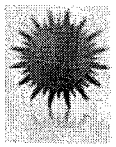
- ***Made in North America*** → Primarily designed and manufactured in North America using automotive supply chain

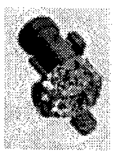
NTR

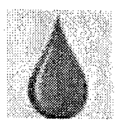
- ***Proven Renewable Energy Development*** → Application of skills ensures successful financing, development & deployment
- ***Community Relations & Permitting*** → Demonstrated ability to permit large scale solar through engagement with local communities
- ***Low Cost Solar*** → Maximizes returns and guarantees marketability. Maximizes value
- ***Modular Scalability*** → Phasing rapidly meets customer goals

Advantages & Innovations

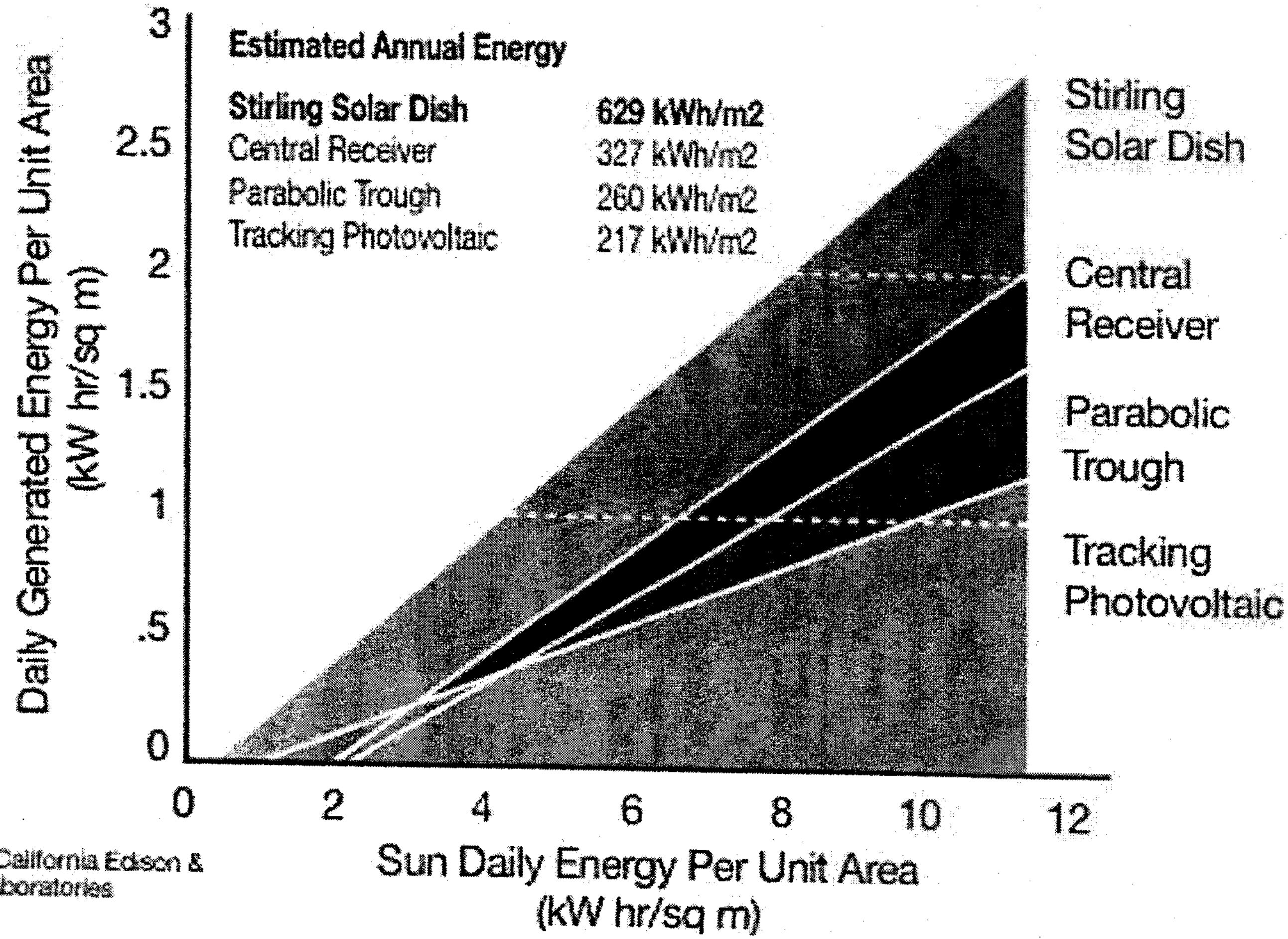
 ***Minimal Footprint & Impact*** → No Excavation. Minimal Grading. Limited Roads. Minimized impact to cultural and environmental resources

 ***Highest on Sun Availability*** → Built in redundancy with modular design, provides increased energy security

 ***Proven Technology & Reliability*** → Enables best commercial application and practices

 ***Lowest Water Use*** → Allows maximum development without impacting water availability/existing base architecture

Efficiency Advantage versus Peer Technologies



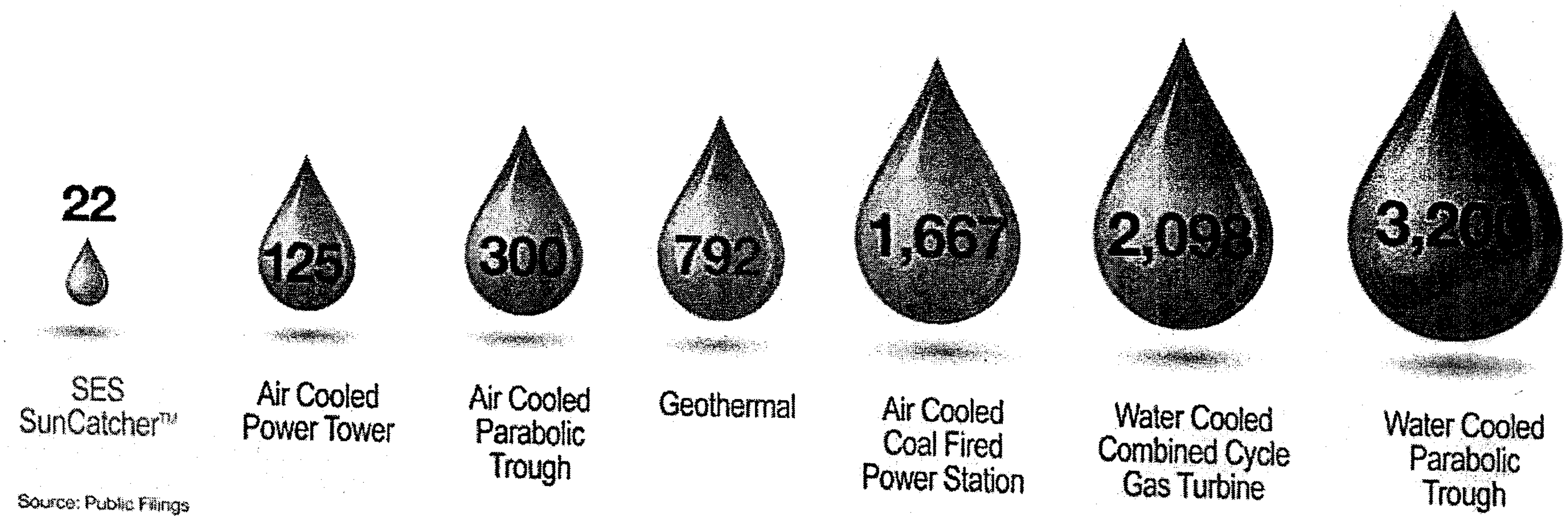
Source: Southern California Edison & Sandia National Laboratories

SES's SunCatcher is the most efficient CSP technology

Water Use

SunCatcher™ Plant Water Usage vs. Other Technologies

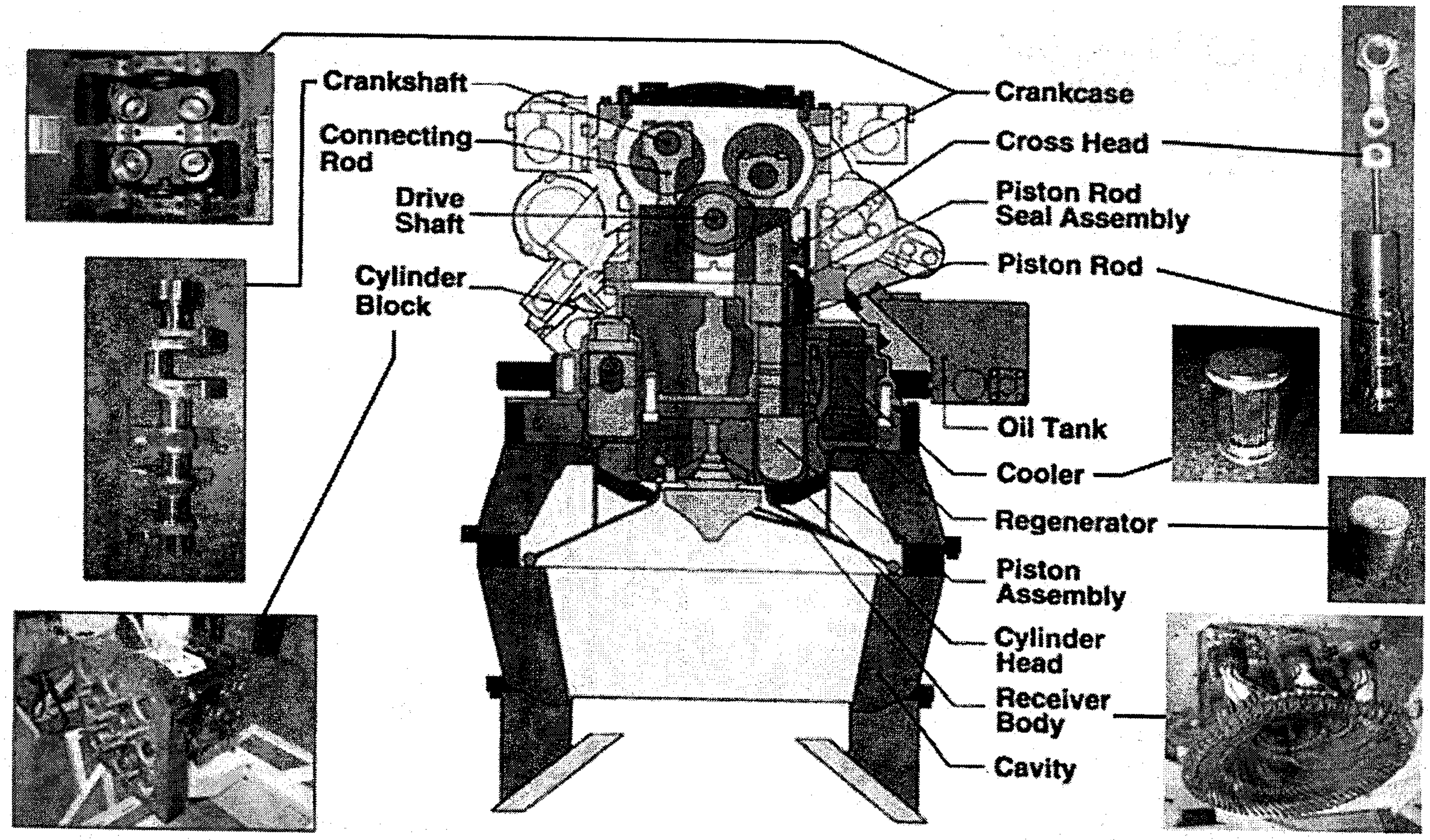
Amount of Water Required for a 500MW Plant
(acre feet per year)



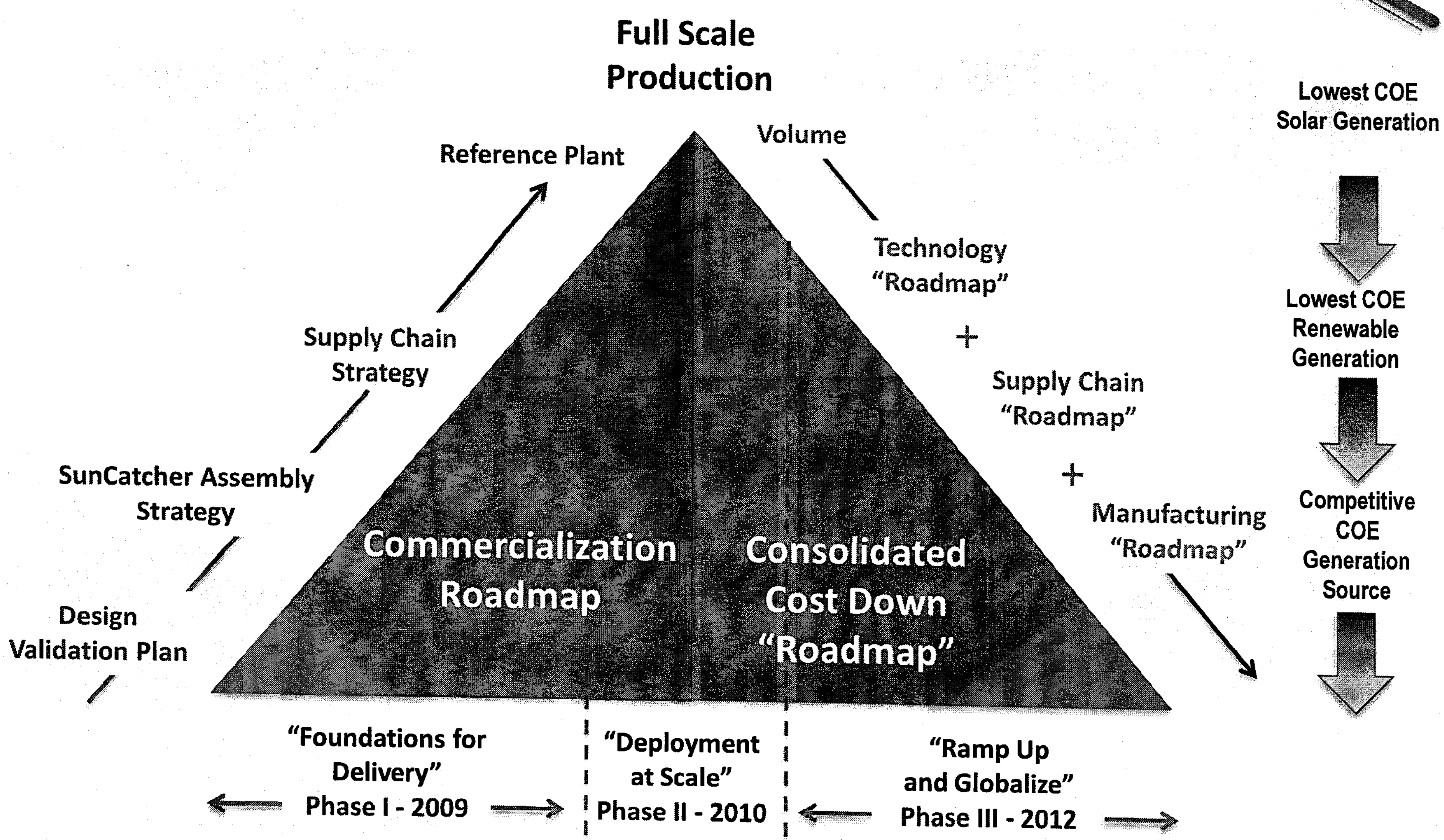
Source: Public Filings

SunCatcher™ - Zero Water Use for Power Production

The Stirling Engine



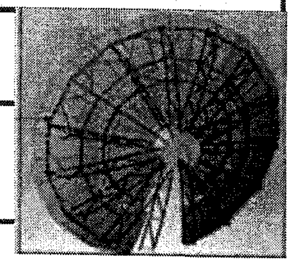
SES Commercialization and Serial Production Plan



Operational Experience

Equivalent Daily Solar Operation

- Power Conversion Unit
  175,000 Hrs On-Sun & Test Cell
  53 Years
- Dish Concentrator
  120,000 On Sun
  36 Years
- Complete System
  50,000 Hrs On Sun
  15 Years

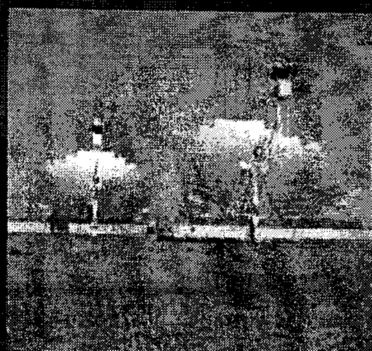


Feb-2008: New World's Record for Sun-to-Grid Efficiency at 31.25%

- 6 SunCatchers™, each an individual power plant, have been in operation in Sandia National laboratories since 2005
- 4 new-model SunCatchersTM operational in Sandia since beginning of May 2009
- Reference plant consisting of 60 SunCatchers (1.5 MW) will be operational by early 2010 in Arizona

Commercialization Path

Past... Today
"Technology"



Starting Point

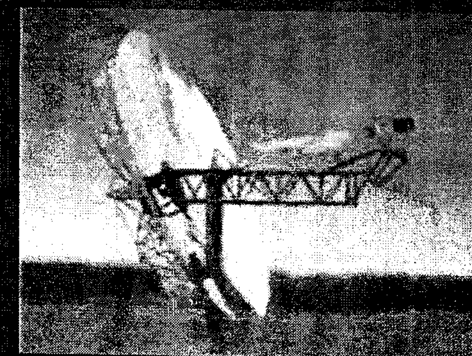
- 20 Year History
- Development units
  - HB, NV, SA, SNL
- Model Power Plant
  - 6 Systems
  - SES Supply Chain

Commercialization Program

- Product Commercialization
- Supply Chain Development
- Development Projects
  - Model Power Plant (On-Sun)
  - ALT Test Rigs
- Company Infrastructure

Bridging the Gap

"Commercialization"



Goals

- US & International Markets
- Supply Chain—US Based with Global Reach
- Ultra-Low Cost Systems
- High Volume Manufacturing
- Advanced Systems

Signed Projects

SES Solar One Project (Calico)

- Capacity: 500 MW with Expansion Option to 850 MW
- 20-Year Power Purchase Agreement with Southern California Edison
- Sited in the Mojave Desert East of Barstow
- Construction Scheduled for 2010 or 11 through 2014

SES Solar Two (Imperial Valley)

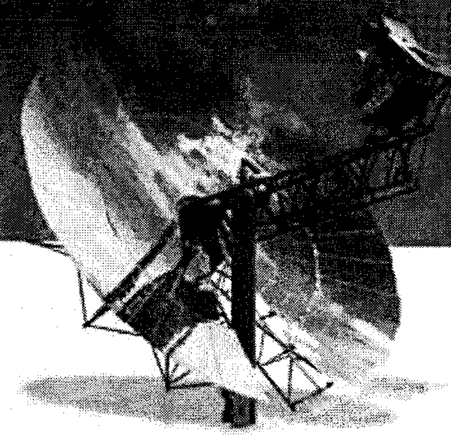
- Capacity: 300 MW options for two additional 300 MW Phases for a total of up to 900 MW
- 20-Year Power Purchas Agreement with San Diego Gas & Electric
- Sited in Imperial Valley
- Construction from 2010 to 2011 for Initial 300 MW
- Transmission to support first 300 MW available on existing system

Western Ranch Solar Project

- Capacity: 27MW with Expansion up to 130MW
- 20 year Power Purchase Agreement with CPS Energy
- Sited in West Texas
- Construction from Summer 2010 by end of 2010

Reference Plant (Arizona)

- Capacity: 1.5 MW with expansion possibilities up to 130MW
- Located in Metropolitan Phoenix, Arizona
- Construction from Fall 2009 to January 2010



Conclusion

1) Stirling Energy Systems is on track to meet deployment schedules for reference plants and signed projects

2) Stirling Dish Systems are Proven technology with the highest efficiency and the most cost effective solar solution.

3) The Stirling systems uses no water for production cycles, only to clean mirrors allowing the lowest amount of water. Preserving our precious water resources.

4) The system is environmentally sound with minimal land disturbance.

Pure Power Made Simple

Thank you

DOCUMENT 4

WorleyParsons

resources & energy

WorleyParsons Report No. FPLS-0-LI-450-0001
WorleyParsons Job No. 52002501

DOCKET
08-AFC-2
DATE FEB 01 2008
RECD. JAN 05 2009

FPLE - Beacon Solar Energy Project Dry Cooling Evaluation

FPLS-0-LI-450-0001 Rev B

Prepared for:
FPL Energy

Prepared by:
WorleyParsons Group, Inc.
2330 E. Bidwell Suite 150
Folsom, California 95630 USA

February 1, 2008

Zero Harm
Leadership
No Incidents
Safe Behavior

PROOF OF SERVICE (REVISED 11/10/08) FILED WITH
ORIGINAL MAILED FROM SACRAMENTO ON 1/6/09
AA

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Any questions concerning the information or its interpretation should be directed to Geoff Baxter, Project Manager.

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List of Appendices

1. INTRODUCTION

FPL Energy (FPLE) has hired Worley Parsons to provide conceptual design and permitting support for the Beacon Solar Energy Project (Beacon), a 250 MW parabolic trough solar facility. The base design of the facility includes a surface condenser and wet cooling tower for condensing the steam turbine exhaust. Groundwater is proposed as the source of makeup water to the cooling tower and all other plant needs. At the request of FPLE, WorleyParsons has evaluated alternatives to the base cooling design. This report serves to document the gathered information, analysis and conclusions regarding the base and alternate cooling methods. In addition, information from this report will be incorporated into the Beacon Solar Energy Project California Energy Commission (CEC) Application For Certification (AFC).

Two alternate cooling technologies have been considered - dry cooling with an air cooled condenser (ACC), and wet/dry hybrid cooling systems. (Note: The wet/dry hybrid is sometimes called a parallel condensing system and is different than a wet/dry cooling tower that is designed specifically for plume abatement). For each of the dry and hybrid technologies, three options reflecting different pricing, sizing, performance and water use (hybrid only) have been considered. The inclusion of multiple options in each cooling technology provides a feel for the sensitivity of the different options on key parameters.

The base and two alternate technologies have been evaluated and are described below in the following categories: Design Assumptions, Capital Costs, Thermal Performance, and Water Treatment and Consumption.

2. DESIGN ASSUMPTIONS AND METHOD

2.1 Base Design - Wet Cooling

The base design cooling system consists of a steam surface condenser, circulating water pumps, and an induced draft counter-flow cooling tower. The induced draft tower is understood to have the lowest life cycle cost for this 250 MW size facility compared to other cooling tower types.

The design assumptions for the wet cooling design are as follows:

Dry Bulb	103.5 deg F
Wet Bulb	68 deg F
Cooling tower approach temp	9 deg F
Cooling tower range	20 deg F
Circulating water flow rate	149,000 gpm
Condenser Terminal Temperature Difference (TTD)	5 deg F

The base design achieves a steam turbine back pressure of 2.1 inches HgA at the rated 250 MW and the stated design conditions.

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Safe Behavior

when experience counts

2.2 Dry Cooling

The dry cooling alternative utilizes an air cooled condenser to cool the exhaust steam using a large array of fans that force air over finned tube heat exchangers. The heat is rejected directly to the atmosphere, and no external water supply is needed. Three different options having inlet temperature differences (ITD) of 35 °F, 40 °F, and 45 °F, were considered for the dry cooling alternative. The ITD is defined as the difference between the ambient air temperature at the design point and the steam condensation temperature within ACC. The smaller the ITD, the more aggressive the design resulting in better STG backpressure but at a higher cost. An ITD of around 40 °F is considered typical in the industry. For purposes of this evaluation a more aggressive option of 35 °F ITD, and a more conservative option of 45 °F ITD, were also considered.

The sizing criteria in the following table were used to obtain budgetary quotes from a vendor:

Table 1 – ACC Design Criteria

			Option 1	Option 2	Option 3
			35 ITD	**40 ITD**	**45 ITD**
Parameter		Units	**Value**	**Value**	**Value**
Ambient Conditions					
	Elevation	ft	2,314	2,314	2,314
	Temperature (DB)	°F	103.5	103.5	103.5
	Temperature (WB)	°F	68.0	68.0	68.0
	ITD	°F	35	40	45
Steam Turbine Exhaust Enthalpy		Btu/lb	1,045.8	1,054.6	1,063.6
Steam Turbine Exhaust Flow		lb/hr	1,848,207	1,884,259	1,919,791
Steam Turbine Exhaust Back Pressure		Inches HgA	6.24	7.06	8.00

The three options shown here provide a range of pricing and performance of dry cooling systems. However, if it is determined that dry cooling will be used, further items must be considered in the ACC sizing in conjunction with the STG supplier including maximum exhaust pressure alarm and trip pressure. Option 2 and Option 3 ACC designs shown here may not meet the STG back pressure requirements at the high ambient temperature conditions for one or more STG supplier designs.

2.3 Wet-Dry Hybrid Cooling

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The hybrid cooling system is a combination of wet and dry cooling, utilizing both a wet cooling tower/surface condenser and an ACC in a parallel configuration. In this way the air cooled portion can be used as the primary heat sink and the water cooled portion supplements the cooling load at higher ambient conditions as needed. Utilizing the air cooled portion for the majority of operation, the hybrid system reduces plant water consumption and wastewater generation significantly. However, a hybrid cooling system has the additional complexity of redundant cooling systems, which tends to drive costs higher.

The hybrid system splits the cooling duty between wet and dry systems, and the split between wet and dry cooling can be adjusted to almost any ratio. For this evaluation, three separate ratio split options were assumed and used to analyze the hybrid cooling system performance. The ACC was sized for a desired steam turbine exhaust pressure at a specific net output at the annual average ambient conditions, and the wet cooling tower was then sized to accommodate additional cooling duty as needed to achieve a desired steam turbine exhaust pressure at the hot day design point ambient conditions while having a net plant output of 250 MW.

The sizing criteria in the following table were used to obtain budgetary quotes from a vendor:

Table 2 – Wet/Dry Hybrid Design Cases

			Option 1	Option 2	Option 3
Parameter		**Units**	**Value**	**Value**	**Value**
Ambient Conditions					
	Elevation	ft	2,314	2,314	2,314
	Temperature (DB)	°F	71.0	71.0	71.0
	Temperature (WB)	°F	52.0	52.0	52.0
Dry Cooling Design Point			**250 MW NET**	**200 MW NET**	**150 MW NET**
Steam Turbine Exhaust Enthalpy		Btu/lb	1,010.0	1,010.0	1,010.0
Steam Turbine Exhaust Flow		lb/hr	1,672,843	1,272,761	1,084,459
Steam Turbine Exhaust Back Pressure		Inches HgA	2.97	2.97	2.97
Combined Hybrid System Requirements			**250 MW NET**	**250 MW NET**	**250 MW NET**
Ambient Conditions					
	Temperature (DB)	°F	103.5	103.5	103.5
	Temperature (WB)	°F	68.0	68.0	68.0
Steam Turbine Exhaust Enthalpy		Btu/lb	1,033.1	1,033.1	1,033.1
Steam Turbine Exhaust Flow		lb/hr	1,779,347	1,779,347	1,779,347
Steam Turbine Exhaust Back Pressure		Inches HgA	5.10	5.10	5.10
Maximum Duty		MMBtu/hr	1663	1663	1663

Of these hybrid cooling options, Option 1 has a comparatively larger ACC with smaller surface condenser and wet tower, while Option 3 is the reverse. Note that the largest hybrid option ACC is smaller (by surface area) than the smallest pure ACC Option 3. A key advantage of the hybrid system is the benefit of having the wet cooling tower (which works off the wet bulb temperature) to achieve better steam turbine back pressure on hot days.

2.4 Method

Using the criteria given above, budgetary quotes for ACC and hybrid systems were requested in order to determine impact on performance, cost and water consumption.

Performance models of the steam cycle were created in Gatecycle version 5.61.0.r to evaluate the impact of the different cooling systems on cycle output and efficiency.

Vendor cost data was combined with estimates for installation to arrive at installed costs for the different alternatives. Care was taken to account for the changes in scope, such as removal of the circulating water pumps and the addition of an auxiliary cooling source for a stand alone ACC system.

Impacts of the cooling system on water consumption and water treatment equipment were done by calculating the operating point and annual water consumption, and evaluating the changes in the water treatment equipment for the different alternatives.

For the Life Cycle Cost Analysis discussed in section 6 two scenarios were evaluated. One scenario assumes that the solar field size is held constant and the annual net output of the plant decreases due to the efficiency impact for each cooling technology alternative. The second scenario assumes that the solar field size will increase to offset the efficiency impact for each cooling technology alternative. In both cases boiler feed water pumps, HTF Pumps, and the Steam Generator Heat Exchanger sizes were changed to accommodate increase in steam and HTF flow

The results of the evaluation are presented in the following sections.

3. CAPITAL COSTS

Capital costs have been determined using a combination of vendor budgetary proposals, in house equipment cost estimates, and in house installation cost estimates. The capital costs should be considered as +/- 30% range of accuracy. However, the relative accuracy between the various options (e.g. option A compared to option B) is considered +/-10%.

As expected, there is a wide range in capital cost among the three alternatives, as well as among the different options considered for the dry and hybrid cooling systems. Differences in operating costs and plant performance are covered in later sections of this document.

3.1 Base Design Cooling System

Worley Parsons obtained a budgetary quote for an 11-cell wet cooling tower for $4,275,000. An earlier budgetary quote for the condenser has been adjusted for the current performance requirements. The quotes and data sheets are included in Appendix A. Other internal estimates were used for the circulating water piping, circulating water pumps, and installation costs.

3.2 Air Cooled Condenser

Worley Parsons obtained a budgetary quote covering three different ACC designs as specified in the design assumptions. The full quote and data sheet is included in Appendix B. Installation costs were estimated internally. For the ACC only alternative, costs were also included for an air cooled auxiliary cooling water system.

3.3 Wet/Dry Hybrid System

WorleyParsons obtained a budgetary quote covering the ACC and wet tower equipment for the three hybrid options as specified in the design assumptions. A full quote with base material scope and specifications is included in Appendix C. It was not possible to obtain budgetary quotes for the surface condensers, which have been estimated using in house information.

The following table is a summary of the complete cost analysis showing the line items that build up the overall total installed capital cost for the seven different options (one base option, three ACC options and three hybrid options). Installed costs are summed with and without consideration of the water treatment equipment, which is discussed further within this report.

Table 3 – Capital Cost Summary

Case	Base	ACC 1	ACC 2	ACC 3	Hybrid 1	Hybrid 2	Hybrid 3
Description	Cooling tower	35 ITD	40 ITD	45 ITD	250 MW ACC	200 MW ACC	150 MW ACC
Number of cooling tower cells	11				3	4	4
Number of ACC cells		42	40	35	35	25	20
HTF Pumps Estimated Capital Cost	$3,000,000	$3,300,000	$3,300,000	$3,300,000	$3,150,000	$3,150,000	$3,150,000
Boiler Feed Water Pumps Estimated Capital	$2,300,000	$2,400,000	$2,400,000	$2,400,000	$2,320,000	$2,320,000	$2,320,000
Steam Generator Heat Exchanger Estimated Capital Cost	$12,500,000	$14,100,000	$14,100,000	$14,100,000	$13,400,000	$13,400,000	$13,400,000
Solar Field Sizing [1]	$410,000,000	$463,000,000	$463,000,000	$463,000,000	$441,000,000	$441,000,000	$441,000,000
Cooling tower Estimated Cost	$4,275,000				$1,025,000	$1,475,000	$1,675,000
Cooling tower basin + installation Estimated Cost	$1,500,000				$350,000	$450,000	$500,000
Circulating Water pumps + installation Estimated Cost	$600,000				$265,000	$350,000	$375,000
Surface Condenser + installation Estimated Cost	$3,500,000				$700,000	$875,000	$975,000
Circulating Water piping Estimated Cost	$1,300,000				$750,000	$950,000	$1,050,000
Circulating Water piping installation Estimated Cost	$520,000				$400,000	$450,000	$500,000
ACC Equipment Only		$42,500,000	$36,900,000	$33,300,000	$28,260,000	$21,860,000	$19,620,000
ACC Installation		$12,075,000	$11,500,000	$10,062,500	$10,062,500	$7,187,500	$5,750,000
Closed cycle aux cooler (installed)		$450,000	$450,000	$450,000			
Water Treatment Capital Cost-Installed	$21,158,000	$2,500,000	$2,500,000	$2,500,000	$11,116,000	$11,116,000	$11,116,000
TOTAL CAPITAL COST with Solar Field Size Consideration	**$460,653,000**	**$540,325,000**	**$534,150,000**	**$529,112,500**	**$512,798,500**	**$504,583,500**	**$501,431,000**
TOTAL CAPITAL COST without Solar Field Size Consideration	**$50,653,000**	**$77,325,000**	**$71,150,000**	**$66,112,500**	**$71,798,500**	**$63,583,500**	**$60,431,000**

1. Solar field capital cost applies to the case where the solar field size is increased to offset lower cycle efficiency.

4. PERFORMANCE

ASHRAE climate data has previously been used to establish the summer design point, annual average and winter ambient conditions for the facility. These ambient conditions were used in the Beacon project heat and mass balances for the base design, which have been issued to FPLE. Appendix D shows a complete summary of the ambient conditions that were used for the cycle design.

The issued heat balances have been used as the baseline for performing the alternative cooling performance calculations. The heat balances established an assumption for the solar energy available at the annual average and winter operating points. The performance modeling used to generate these results for the alternative cooling methods has used those assumptions for the annual average and winter operating conditions.

One area where this analysis differs from the issued heat balances is at the hot day design point. In light of the FPLE requirement that the facility should have 250 net MW regardless of heat rejection system, and because air cooling requires greater solar thermal energy input to achieve the desired electrical generation, it has been assumed that there is sufficient solar thermal energy available from the field to generate the necessary steam flow for the alternate cooling system cycles to meet 250 net MW. In reality, this means that the cycles other than the base are encroaching upon the established solar multiple of the base design having wet cooling.

Because of the requirement to meet 250 net MW at the design point, the performance table below shows equal plant output for all the cooling options at this operating condition. The performance item that then distinguishes the cooling options is the steam cycle efficiency, so that a lower efficiency translates to increased solar thermal energy needed for the steam cycle.

Various Gatecycle models were created to model the different cooling configurations. They were created at the model design point using vendor information, and then run at "off design" conditions to determine plant performance for the annual average and winter ambient.

There has been some effort within Gatecycle to optimize the steam turbine for the different types of cycles, recognizing that the operating back pressure heavily influences the size of the steam turbine last row blade. Different last row blade lengths were modeled for the ACC and hybrid options as compared to the base design options. This modeling was done based on generic information, not tied to specific vendor information.

The calculation of steam cycle efficiency has been done on a net power basis, after subtraction of the auxiliary loads from the gross generation.

4.1 Base Design Cooling System

The performance shown for the base cooling system is taken directly from the issued heat balances.

4.2 Air Cooled Condenser

Three different design cases using an ITD of 35°F, 40°F, and 45°F were used to model the ACC performance.

4.3 Wet/Dry Hybrid System

Plant performance was modeled for the three different hybrid cooling cases using Gatecycle software. The wet cooling tower was sized according to the size of the ACC for each case in order to maintain the base case output of 250 MW. Table 4 shows the wet cooling tower sizing used for the hybrid performance analysis.

Table 4– Wet Cooling Tower Sizing for Hybrid Design

Case		**Hybrid 1**	**Hybrid 2**	**Hybrid 3**
Wet Cooling	**Units**	**3-Cell Tower**	**4-Cell Tower**	**4-Cell Tower**
Flow	gpm	41,768	63,811	74,039
Evaporation	gpm	1003	1530	1775
Footprint	ft^2	6336	9504	11988

4.4 Performance Results

Table 5 is a summary of the complete performance analysis showing the net output and the steam cycle efficiency for the seven different options across the specified ambient conditions.

Table 5 – Performance Summary

Performance Summary						
Cooling Option	Design Point		Annual Average		Winter Conditions	
	Net Output(MW)	Steam Cycle Efficiency(%)	Net Output(MW)	Steam cycle Efficiency(%)	Net Output(MW)	Steam cycle Efficiency(%)
Base Design	250.0	34.7	151.6	33.7	54.3	37.5
ACC (35 ITD)	250.0	31.4	141.4	31.4	49.2	25.0
ACC (40 ITD)	250.0	31.1	142.8	31.7	49.2	24.9
ACC (45 ITD)	250.0	30.6	143.0	31.7	49.4	25.1
Hybrid 1	250.0	32.6	145.0	32.2	*49.2	*25.0
Hybrid 2	250.0	32.6	143.8	31.9	*49.2	*25.0
Hybrid 3	250.0	32.6	141.4	31.4	*49.2	*25.0

*Note: Hybrid performance was not evaluated for winter ambient conditions. Values are based on ACC performance.

4.5 Performance Discussion

As noted previously, at the design point all cooling scenarios were run to achieve the desired 250 net MW. The steam cycle efficiency is the differentiator, showing the inefficiencies of the dry and hybrid cooling options compared to the base design. There is a significant decrease in cycle efficiency moving to the ACC options. Within those options, the level of aggressiveness in sizing the ACC is reflected in the efficiency results. For the hybrid alternative, the design point results are considered identical. Per the design criteria for the hybrid systems, the design point steam turbine back pressure is the same for the three hybrid options, therefore it is expected that the cycle performance is the same for the three.

At the annual average operating point there are differences in power output and cycle efficiency. This is also expected since all the cases at the annual average point were run with the same solar thermal energy input as was defined in the issued heat balances using the wet cooling option. The significant decrease in both power output and cycle efficiency for all options other than base shows the ability of the wet tower to achieve better back pressure at the annual average conditions.

The pure ACC options show very similar performance. From modeling it was determined that all three ACC's, despite having notable performance differences on the hot day, were able to reach the assumed minimum ACC operating pressure of 2.0 Inches HgA. (If not limited by user, the different designs achieved predictable different pressures, but the 2.0" limit was applied based on real world experience.) Because the steam turbine back pressure is the same for the three ACC options, the gross steam turbine output was essentially the same, and the only difference in performance being subtle changes in auxiliary loads. The three ACC options can be considered equal in performance at the annual average condition.

At the annual average condition it was determined that the hybrid options could all be run with only the ACC in service, the wet tower and condenser being out of service. Because of the smaller ACC's used in the hybrid options compared to the pure ACC options, none of them achieved the 2.0" HgA lower pressure limit. There were subtle differences in back pressure across the three options that are reflected in the performance. As a whole the hybrid options show about equal performance as the pure ACC's despite having slightly higher back pressure, a difference that is probably due to steam turbine optimization. In practical terms, the pure ACC and hybrid options have comparable performance at the annual average point.

At the winter operating conditions, all the ACC and hybrid designs were limited to the 2.0" HgA lower operating limit, and have essentially the same performance. The base design is clearly better, being able to operate at a lower back pressure.

5. WATER TREATMENT AND CONSUMPTION

Wells 63, 48 and 43 for the Beacon Project were sampled and analyzed for key chemistry parameters important for identifying the required water treatment and chemical feed systems. Silica was measured in concentrations between 30 and 35.9 ppm, thus providing constraints on the cycles of concentration for the cooling tower without treatment. Silica saturation limit at cooling water chemistry conditions is approximately 150 ppm, thus limiting the cycles of concentration (COC) to approximately 4 without a silica inhibitor. In addition, the alkalinity of Well 48 was elevated (290 ppm) compared to Well 63 (160 ppm) and Well 43 (170 ppm), thus potentially requiring more sulfuric acid and possibly limiting the COC also to approximately 4 to maintain 800 ppm sulfate as CaCO3. The presence of calcium can cause scale when cooling tower water is cycled up, and scale inhibitor should be used as a preventative measure. With the makeup water chemistry, plant conditions and cycles of concentration modeled, the WaterCycle program indicated that scale could be prevented with a scale inhibitor, and thus calcium is not considered a limiting parameter.

5.1 Wet Cooling Vs. Dry Cooling

Parallel work on the water treatment systems has resulted in three categories or options; minimal makeup treatment and no blowdown treatment (Option 1), makeup pre-treatment only (Option 2), and blowdown post-treatment only (Option 3). Based on the makeup water chemistry and limited cycles of concentration (COC) that can be achieved without makeup water treatment using a wet condenser design, the pre-treatment option (Option 2) is considered the base for this evaluation, and the costs for this design are aligned with the wet tower base design. For the alternative cooling technologies, additional options are being considered for the different water treatment design conditions that the cooling systems present. Therefore, the pre-treatment Option 2 will be compared with water systems needed to support air cooled condenser operation (Option 4). (Note that number of Options for water treatment is different than the numbering of the ACC or hybrid cooling options).

The pre-treatment option for the Beacon project takes into account the silica concentration in the makeup water that limits the COC that can be achieved in the cooling tower to approximately 4 without treatment. The pre-treatment components would consist of an ion exchange system containing strong acid cation exchange vessels, a degasifier, and strong base anion exchange vessels. The system would be regenerated on site, and therefore would require sulfuric acid and sodium hydroxide chemical storage tanks. Water upstream of the ion exchange system would be contained within large Service Water Storage Tanks and downstream of the demin would be contained in a Treated Water Storage Tank (e.g., with a combined storage of ~5,190,000 gallons). A small storage tank for Demin Water and Neutralized Water Storage Tanks would also be required. With some raw water feed to the cooling tower (e.g., 5-20%), the cooling tower would require commonly used chemicals including sulfuric acid, sodium hypochlorite and scale inhibitor (with usage volumes being reduced compared to cooling water without pre-treatment). The steam cycle would also require makeup water treatment, which could be accomplished with a mixed bed demineralizer system to provide final polishing.

Using pre-treatment ion exchange provides the benefit of reducing the potential for silica scale, calcium scale, and sulfuric acid corrosion, eliminates the need for reverse osmosis for steam cycle makeup, and allow the cooling tower COC to increase (e.g., ~15), thereby reducing wastewater. This option for wet cooling will result in an annual makeup of approximately 3353 gpm with summer makeup increasing to 4054 gpm. Blowdown to the evaporation ponds will be approximately 462 gpm annually with blowdown increasing in the summer to approximately 563 gpm due to increased evaporation.

In comparison, the makeup water required to support an ACC would be reduced and would consist primarily of the volumes necessary for reverse osmosis feed (creating demin water for steam cycle makeup and mirror washing), and quench water. Makeup for these systems would be approximately 178 gpm with wastewater flow of approximately 82 gpm annually. These flows would increase by approximately 10% in the summer.

The water system required with an ACC would consist of components designed to provide high-purity water to the steam cycle and for mirror washing. This system would consist primarily of a pre-filter (for iron and manganese removal), a reverse osmosis system and an ion exchange system (e.g., mixed bed polishing vessel). Smaller tanks would be required for the Service Water Storage Tank and Demin Water Storage Tank. Reverse osmosis reject and steam generator blowdown would be diverted to evaporation ponds. With blowdown flow using the ACC approximately 20% of the wet cooling option, the acreage of evaporation ponds would also be reduced proportionately from approximately 25 acres of evaporation ponds for wet cooling to 5 acres of evaporation ponds for an ACC.

Capital costs for the pre-treatment option (Option 2) for wet cooling include an ion exchange system for makeup, chemical feed for demin regeneration, chemical feed for circulating water, chemical and water storage tanks, a mixed bed demin for steam cycle makeup, and 25 acres of evaporation ponds. An estimate for the Capital Cost for these items is $21,158,000. O&M costs for the water treatment system are $1,420,000 per year, excluding labor. The volume required for makeup is approximately 1599 acre-feet per year.

Capital costs for the water treatment components to support an air cooled condenser (Option 4) include an inlet filter, reverse osmosis, Service Water and Demin Water tanks, and approximately 5 acres of evaporation ponds. An estimate for the Capital Cost for these items is $2,500,000. O&M costs for the water treatment system are $132,000 per year, excluding labor. The volume required for makeup is approximately 79 acre-feet per year. See Appendix E for a full cost comparison of capital and O&M costs between the wet cooling tower and the ACC water treatment systems. (Note: These values are rough estimate based on a conceptual design, and are not based on quoted prices from suppliers. O&M costs are based on chemicals and power, and do not include labor).

5.2 Wet Cooling Vs. Hybrid Wet/Dry Cooling

Hybrid cooling (Water Treatment Option 5) uses water from the circulating water system during the hottest days when air cooling is insufficient to maximize electrical power output and supplemental wet cooling is necessary. In order to support hybrid cooling, a circulating water system will be needed to enable evaporation rates ranging from approximately 1400 gpm to 2300 gpm. To support the circulating water system, chemical feed including sulfuric acid, sodium hypochlorite and scale inhibitor will be needed. Since silica is present in makeup water, pre-treatment is suggested to increase the cycles of concentration (COC) in the circulating water.

Ion exchange pre-treatment provides the benefit of reducing the potential for silica scale, calcium scale, and sulfuric acid usage and potential acid corrosion, eliminates the need for reverse osmosis for cycle makeup, and allows the cycles of concentration in the cooling tower to increase (e.g., ~15). The option for a water pre-treatment system used for wet cooling will result in a summer makeup of approximately 2502 gpm. Blowdown to the evaporation ponds will be approximately 144 gpm in the summer months and discharge to the evaporation ponds will be approximately 349 gpm.

A high-purity water system is also required for a hybrid plant's steam cycle and would consist of an ion exchange system for steam cycle makeup and mirror washing, consisting of a mixed bed vessel (possibly to be regenerated off-site) along with a Demin Water Storage Tank. These components would be used regardless of whether the condenser is using wet or dry cooling.

The circulating water system required for a hybrid cooling system would consist of components designed to reduce silica, calcium and alkalinity to the cooling water to enable cycling up of the water (e.g., ~15). The system would consist of a cation exchange vessel, a degasifier, and anion exchange vessel. The system would be regenerated on site, and therefore would require sulfuric acid and sodium hydroxide chemical storage tanks. Water upstream of the ion exchange system would be contained within large Service Water Storage Tanks and downstream of the demin would be contained in a Treated Water Storage Tank. A small storage tank for Demin Water and Neutralized Water Storage Tanks would also be required. With some raw water feed to the cooling tower (e.g., 5-20%), the cooling tower would require sulfuric acid, sodium hypochlorite and scale inhibitor (with usage volumes reduced compared to wet cooling options).

This circulating water system will not be required during the winter and perhaps some shoulder months with the plant's power output decreasing significantly (e.g., to 15% or less of maximum power) during the months of November, December and January. The transition from full power operation with hybrid wet cooling to dry cooling would decrease the makeup water required for operation from 2502 to 157 gpm, and would decrease the blowdown from 144 to 0 gpm during this period, although wastewater from ion exchange regeneration would still need to be processed and waste flows would decrease from 349 gpm in the summer to 36 gpm in the winter. As a result, the need for evaporation ponds would decrease, although 10 acres will still need needed to contain the blowdown during the summer months. Chemical feed costs in the winter would also decrease compared to wet cooling.

Capital costs for the water treatment components to support a hybrid system (Option 5) include an ion exchange system for makeup, chemical feed for demin regeneration, chemical feed for circulating water, chemical and water storage tanks, and 10 acres of evaporation ponds. An estimate for the Capital Cost for these items is $11,116,000. O&M costs for the water treatment system are $815,000 per year, excluding labor. The volume required for makeup is approximately 625 acre-feet per year. See Appendix E for a full cost comparison of capital and O&M costs between the wet cooling tower and the hybrid wet/dry system. (Note: These values are rough estimate based on a conceptual design, and are not based on quoted prices from suppliers. O&M costs are based on chemicals and power, and do not include labor).

5.3 Water Consumption

This analysis compares the water consumption between the different cooling options. In order to be able to compare and contrast how the plant's cooling system affects water consumption, water balances were generated for average ambient conditions.

5.3.1 Cooling Tower

The wet cooling tower will consume a large amount of water, which is lost through evaporative cooling and also through blowdown. Water consumption varies depending on fluctuating ambient temperatures, therefore two cases for water treatment options were generated for average summer conditions and average annual conditions. The complete water balances can be found in Appendix F.

5.3.2 Air Cooled Condenser

Utilizing a dry cooling system will consume a minimum amount of water. The ACC is a closed loop system that does not utilize evaporative cooling, and therefore blowdown is not necessary to maintain water chemistry (There will be a minimal loss of about 1% of the steam flow for the HRSG blowdown, which is negligible for this comparison).

5.3.3 Wet/Dry Hybrid System

The hybrid cooling system can be used to reduce water consumption in a flexible manner. The hybrid design allows for variation in the cooling load between the wet and the dry system. This evaluation has considered three hybrid options that require differing amounts of wet cooling and makeup water. When conditions are ideal, the plant will utilize the full capacity of the ACC and achieve no water loss from the ACC due to evaporation or blowdown. When necessary, a fraction of the cooling load can be pushed over to the wet cooling tower at the discretion of the operator. This creates a wide range of water reduction capability for the hybrid system. The size of the ACC is the limiting factor for percentage of water reduction in a hybrid system. For the hybrid system, the cooling tower will dictate the water consumption of the complete cooling system. For purposes of water consumption estimation, wet cooling (Option 2) was compared with the dry ACC cooling (Option 4) and hybrid cooling (Option 5).

Table 6 – Estimated Water Consumption and Water Treatment Costs at *Annual and Summer Conditions*

	OPTION 2: Pre-treatment	OPTION 4: Air Cooled Condenser	OPTION 5: Hybrid Wet/Dry Cooling
Annual/Summer Makeup (gpm)	3353/4054	178 / 192	157 / 2502
Annual/Summer Blowdown (gpm)	197 / 240	0 / 0	0 / 144
Annual/Summer Flow to Evap Ponds (gpm)	462 / 563	82 / 92	36 / 349
Annual Makeup (AFY)	1599	79	625
Annual Makeup Savings (AFY) compared to Opt. 2	0 (compared to Option 2)	1520	974
O&M Costs ($1000) per year (excluding labor)	$1,420	$132	$815
Capital Costs ($1000)	$21,158	$2,500	$11,116

6 LIFE CYCLE COST ANALYSIS

To understand the impact each cooling technology will have during the entire life cycle of the Beacon Solar Energy Project, a Life Cycle Cost Analysis was performed. The purpose of the Life Cycle Cost Analysis (LCCA) is to compare the expected differences in net present value among the three cooling technologies relative to each other. The net present value (NPV) accounts for initial capital costs, ongoing operating costs, and ongoing revenue from generation. The reduction in NPV for the alternative cooling technologies compared to the base is a measure of the economic disadvantage they cause to the project.

The Solar Advisor Model (SAM) software was used to determine the net annual generation for each technology. SAM is limited in modeling dry cooling systems and is currently not designed to model hybrid systems. However, the different cooling technologies result in different steam cycle efficiencies. These cycle efficiencies result in different annual generation as determined using SAM and included in Appendix I. A separate calculation method, which accounts for dry cooling was also performed as a check of the SAM results. For the second method, steady-state heat balance cases were used to create performance curves of the solar energy required for a given output. A simplified integration of solar energy available resulted in the relative difference in net generation between the wet and dry technologies. The results of this method are included as Appendix G and H. Though there were differences in the absolute annual generation between the results of the two methods, the relative difference in generation among the wet and dry cooling technologies was consistent using the two methods. Table 7 summarizes the difference between the net annual output for each technology as calculated by SAM.

Table 7 – Net Annual Output for Different Cooling Technologies Using Same Solar Field Size (all rated for 250 MW under design conditions).

SAM OUTPUT	Base Design (Wet Cooling)	ACC (40 ITD)	Hybrid 2
Estimated Annual Energy Output (MWhr)	**602,527**	**557,365**	**574,771**
% Difference to Base Design	**0.0%**	**-7.5%**	**-4.6%**

The three designs studied for Table 7 have the same size solar field and are each rated for 250 net MW. Since the alternative cooling technologies are less efficient in the steam cycle, it follows that a solar multiple for the alternatives would be less than the a solar multiple for the base design. Table 7 shows the result of the solar multiple in lower annual generation.

In order to maintain the same solar multiple for the different designs, it is necessary to increase the size of the solar field for the dry and hybrid cooling technologies in order to offset the lower steam cycle efficiency. Doing so results in the same net annual generation for the base and alternatives. The LCCA was prepared using both approaches, one keeping the same solar field size and suffering a loss in annual power generation, and the other increasing the size of the solar field to maintain a constant annual net generation.

Net Present Values were determined based on the difference between each alternate technology as compared with the Base Design. Using the capital costs provided by vendors or estimated by WorleyParsons, along with operating and maintenance (O&M) cost estimates, a Life Cycle Cost Analysis was performed for the three different technologies. The results are summarized in Table 8. See Appendix J for the full Life Cycle Cost Analysis.

To develop an estimate for equipment O&M costs for the Wet, Dry, and Hybrid Cooling options a desktop study was performed and a consensus was determined based on the results of the different sources. Considering the wide range of conclusions made in published reports WorleyParsons has estimated $100,000 for an annual O&M cost for the base design and $200,000 for the ACC option. The hybrid option was split between the base design and ACC option. Forty percent of the base design would be used in the hybrid O&M estimate and sixty percent of the ACC option for an estimated annual O&M cost of $160,000

Table 8 – Net Present Value For Alternative Cooling Technologies relative to Base Design (Wet Cooling).

	Dry Cooling Technology		Hybrid Cooling Technology	
	Solar Field Size Held Constant	**Solar Field Size Increased**	**Solar Field Size Held Constant**	**Solar Field Size Increased**
Annual Net Generation Impact relative to Wet Cooling (MWhr)	-45,162	0	-27,756	0
Annual Revenue Impact from Net Generation Impact Relative to Wet Cooling	($6,774,350)	$0	($4,163,410)	$0
Capital Expenses for Dry Cooling Relative to Wet Cooing[1]	($20,497,000)	($73,497,000)	($12,930,500)	($43,930,500)
Total Net Present Value of O&M Expenses relative to Wet Cooling[2]	$12,980,000	$12,980,000	$5,870,000	$5,870,000
Total Net Present Value of Generation Revenue Relative to Wet Cooling	($63,860,000	$0	($39,250,000)	$0
Total Net Present Value Impact relative to Wet Cooling	($71,100,000)	($60,100,000)	($46,300,000)	($38,000,000)

1. The capital costs show in the table include cooling equipment, boiler feed water pumps, HTF pumps, and solar field addition for the case where the solar field size is increased.

2. O&M Expenses include water treatment, operating, and water pumping costs

3. Standard accounting format used for tables. ($) denotes a negative number.

As shown in Table 8 for the case where the solar field is held constant, implementing the dry cooling technology would impact net annual generation by 45,000 MWhr relative to the base design. The total net present value impact for the decrease in generation revenue would be $64 Million. The total net present value difference to implement dry cooling would be $71 Million. For hybrid cooling the net annual generation impact would be nearly 28,000 MWhr relative to the base design. The total net present value impact for the decrease in revenue would be $39 Million. The total net present value difference to implement hybrid cooling would be $46 Million.

If the solar field is increased to offset the reduced steam cycle efficiency, the resulting NPV impact is less than if the solar field is unchanged.

7. CONCLUSION

The wet cooling tower base configuration has the lowest capital cost and far better thermal performance than the alternative cooling technologies. When combined into an overall Life Cycle Cost Analysis, the benefit of the wet cooling base configuration is even more apparent. While it does require a significant amount of makeup water, which is factored into the Life Cycle Cost Analysis of the plant, the advantages in capital cost, performance, and revenue outweigh this concern.

As a solar facility with a relatively fixed amount of insolation, every effort should be taken to maximize the conversion of the sunlight's energy into electricity. Dry cooling performs least efficiently during the summer months when solar energy is most abundant, and the plant should have the greatest output.

BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION OF THE STATE OF CALIFORNIA
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APPLICATION FOR CERTIFICATION For the *BEACON SOLAR ENERGY PROJECT*	**Docket No. 08-AFC-2** **PROOF OF SERVICE** ***(Revised 11/10/08)***

INSTRUCTIONS: All parties shall either (1) send an original signed document plus 12 copies or (2) mail one original signed copy AND e-mail the document to the address for the Docket as shown below, AND (3) all parties shall also send a printed or electronic copy of the document, which includes a proof of service declaration to each of the individuals on the proof of service list shown below:

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DECLARATION OF SERVICE

I, April Albright, declare that on January 6, 2009, I deposited copies of the attached Dry Cooling Evaluation and Notice of Proposed Preliminary Determination of Compliance in the United States mail at Sacramento, CA with first-class postage thereon fully prepaid and addressed to those identified on the Proof of Service list above.

Transmission via electronic mail was consistent with the requirements of California Code of Regulations, title 20, sections 1209, 1209.5, and 1210. All electronic copies were sent to all those identified on the Proof of Service list above.

I declare under penalty of perjury that the foregoing is true and correct.

Original signature in Dockets
April Albright

Attachments

DOCUMENT 5

CITY OF KINGMAN
WATER ADEQUACY STUDY
FINAL REPORT

May 1993

WILLDAN ASSOCIATES
1717 W. NORTHERN AVE., SUITE 112
PHOENIX, ARIZONA 85021

EXECUTIVE SUMMARY

This report and the corresponding appendices provide the foundation upon which the City of Kingman can build its water resources future. The underlying management goal is to secure a dependable and safe water supply in order to support the planning area's economic base and to enhance the quality of life for existing and future residents.

This document will provide policy and programmatic considerations to achieve this goal. In addition, the information contained herein will assist regulatory agencies in making a determination for finalizing the allocation to Kingman pursuant to contract mandates under federal law, and to obtain water adequacy compliance under state law.

BACKGROUND

Unlike other areas throughout the State of Arizona which have both surface water and groundwater to rely upon, the City currently is exclusively dependent on groundwater. However, the City does have an annual allocation of 18,500 acre feet (or six billion gallons) of Colorado River water which it has been unable to put to beneficial use. The Bureau of Reclamation and the Arizona Department of Water Resources have expressed a desire that the City put the water to beneficial use, and are scheduled to review and act upon this matter in November of 1993.

The City engaged the consulting firm of Willdan Associates to perform a water adequacy study for the City and its planning area. This study was to evaluate future water demand and water resource alternatives to meet that demand. The legal, regulatory, environmental and institutional constraints associated with implementing alternatives were to be developed, and the costs of implementing alternatives were to be determined. The area analyzed for this project is the same as identified in the City's general plan and includes lands both inside and outside the existing City limits.

WATER DEMAND

The City is currently producing approximately 5,600 acre feet (or 1.8 billion gallons of water annually to meet existing demand. Residential customers use 77% of this water, commercial customers 8% and public customers 4%. Three percent of this total amount is for accounted for, but unbilled usage, and 8% is unaccounted for or "lost" water.

Based upon the land area and anticipated densities in the City's planning area, the build-out population for Kingman is projected to be 292,577. This buildout should occur between the years 2040 and 2078, depending upon the growth rate of the City. If the existing water consumption rate of the City were to be maintained, a cumulative total of 2.5 to 3.0 million acre feet of water will be required in the next 100 years.

If consumption were to be decreased by ten percent per capita, a cumulative total of 2.0 million acre feet will be required. Conversely, if consumption were increased by ten percent, a cumulative total of 3.4 million acre feet will be required.

GROUNDWATER RESOURCE AVAILABILITY

The hydrogeoligic firm of Kenneth Schmidt and Associates was utilized to determine the amount of groundwater available to the City. Through a review of other studies performed in the area and information pertaining to City wells, an assessment of groundwater quantities and qualities was made. It was determined that, in the Upper Hualapai basin, 4.2 million acre feet of water is available. If was further determined that 10% of water consumed is recharged to the aquifer.

Based upon this analysis and the aforementioned water demand projections, it appears that the City has sufficient groundwater supplies to meet the demands of the next century. Seventy percent of this water lies between 600 feet and 1000 feet below the surface; the City is currently pumping water from approximately 600 feet. The remaining water supply lies between 1000 and 2000 feet below the surface.

The probable location of future well fields appears to be in the areas where growth will occur. Further, water quality appears to be adequate to meet domestic/potable needs. However, continuing field investigation, which includes test well drilling, would be required to confirm these conditions and assist with future planning.

OTHER WATER RESOURCE AVAILABILITY

In addition to groundwater, the City has several other water resource alternatives. These alternatives include:

Direct Usage of Colorado River Water The City could directly use its Colorado River allocation. However, this would require constructing and operating a transmission system from Lake Mohave or Lake Meade. In addition, a water treatment facility would be required in the Kingman area. The cost estimates of constructing this system range from $53 million to $84 million. This alternative is not recommended for implementation by the City at this time.

Effluent Reuse The City has potential for both the direct use and recharge of effluent. The development of effluent supplies; however, is more costly than groundwater pumping. The main purpose in developing a reuse strategy is that effluent utilization displaces the need to use potable water for non-potable activities. With the anticipation that future environmental mandates will be more stringent, disposal of larger amounts of wastewater can be accommodated through aggressive effluent development. Reuse is also a component required by the BOR and ADWR in making regulatory decisions.

Stormwater Capture There is very limited potential for any significant stormwater capture and utilization. This should not detract; however, from the city exploring retention and impoundment benefits as part of the flood control and drainage master planning activities.

Indirect Usage of Colorado River Water Given the high costs associated with construction of the infrastructure necessary for Kingman to directly utilize its Colorado River allocation, and the interest in other users within Mohave County in developing additional water supplies, there is a real potential for the city to exchange its allocation for alternative supply development through negotiated agreements.

Precedence is already being established through the exchange of Central Arizona Project municipal and industrial sub-contract water.

Water Conservation

The BOR and ADWR both require extensive programmatic water conservation efforts to be established in its regulatory determination process. Conservation is sound resource management and its is environmentally responsive. Programs should be based on cost-effectiveness and achievability.

EXTERNAL FACTORS IMPACTING WATER RESOURCE MANAGEMENT

This study included a comprehensive review of existing and proposed state and federal legislation impacting the City's management of its water resources. Critical items include:

- Evaluation of potential Clean Water Act reauthorization impacts;
- Evaluation of potential Safe Drinking Water Act reauthorization impacts;
- Evaluation of potential Endangered Species Act reauthorization impacts;
- Review of the proposed BOR rules for administration of Colorado River water allocations;
- Review of BOR Reclamation Law contracting requirements;
- Review of the proposed ADWR assured water supply and water adequacy rules;
- Participation in, on behalf of the city, drafting amendment language to state legislative initiatives so as to protect Kingman's ability to develop groundwater supplies from different basins;
- Review of ADEQ public health requirements for drinking water; and,
- Scoping potential for water exchange possibilities, including participation in responding to, on the City's behalf, ADWR proposed criteria.

SUMMARY

The City of Kingman appears to have adequate groundwater supplies to meet the needs of the next century. It is recommended that the City's Colorado River allocation should be put to use indirectly via exchanges with other Mohave County water users. These users can provide funding which will enable the City to solidify its existing groundwater supplies and implement water conservation and effluent reuse programs.

CITY OF KINGMAN
WATER ADEQUACY STUDY
REPORT INDEX

CHAPTER ONE

INTRODUCTION

PURPOSE OF REPORT

The City of Kingman has a Colorado River allocation of 18,500 acre feet per year, or six billion gallons annually. This allocation was obtained in 1968 under a contract with the United States Department of Interior Bureau of Reclamation. To date the City has not directly used its allocation; this matter is scheduled to be reviewed by the Bureau in late 1993. In addition, the Arizona Department of Water Resources (ADWR) desires the beneficial use of this water. Both ADWR and the City have expressed an interest in ensuring the long-term water resource needs of Kingman are met.

In September, 1992 the City of Kingman engaged Willdan Associates to perform a water adequacy study for the City and its planning area. This study was to achieve the following objectives:

Evaluate Future Water Demand The water demand analysis phase of the project was to consider water consumption information by customer classification, water uses, and geographic areas. Using the City's general plan, the analysis was to develop alternatives for land use development and the timing of that development. Water consumption alternatives were to be prepared based upon these land use alternatives, and a consensus water demand projects was to be prepared.

Evaluate Groundwater Production Potential The groundwater analysis phase of the project was to evaluate existing wellfields operated by the City as well as other wells in the project planning area. The analysis was to consider other hydrogeologic studies sponsored or participated in by the City. An estimate of water quality and quantity as well as location was to be made.

Evaluate Other Potential Water Sources The water resource phase of this project was to develop potential water resources (other than groundwater) to meet the immediate and long-term needs of the City. These other water sources include (but are not limited to) surface water, effluent reuse, water conservation, and provider system improvements.

Evaluate External Factors The external factor evaluation phase of this project was to determine the legal, regulatory, environmental, and institutional constraints and conditions impacting immediate and long-term water resource development. In addition, this phase was also to develop alternatives for mitigating these factors.

Evaluate Economic Feasibility/Cost Benefit Aspects of Water Resource Alternatives The economic/financial feasibility phase of this project was to determine costs and benefits of constructing and operating the various water resource alternatives. In addition, this phase was also to determine mitigation costs and legal costs related to water resource development and operations. Alternatives for financing these costs were to be developed in conjunction with City staff and the City's financial advisors.

These evaluations and analyses were to be combined into a single, comprehensive project report. This report was to be presented to staff, the City Council, and regulatory agencies.

DESCRIPTION OF PROJECT PLANNING AREA

The City of Kingman Planning Department has recently completed The City of Kingman General Plan. Included in this general plan is the area within the City's incorporated limits as well as areas of influence outside of the City. These combined areas, referred to in this report as the "project planning area" are presented in Exhibit 1-1. The six geographic areas identified by the general plan, and used for regional classification and analyses in this report, are as follows:

Area One - Downtown Area Original townsite area, primarily north of Andy Devine.

Area Two - Hilltop Area Area east of Stockton Hill Road.

Area Three - Hualapai Mountain Area Area east of Andy Devine, extending north to the Township 21 boundary.

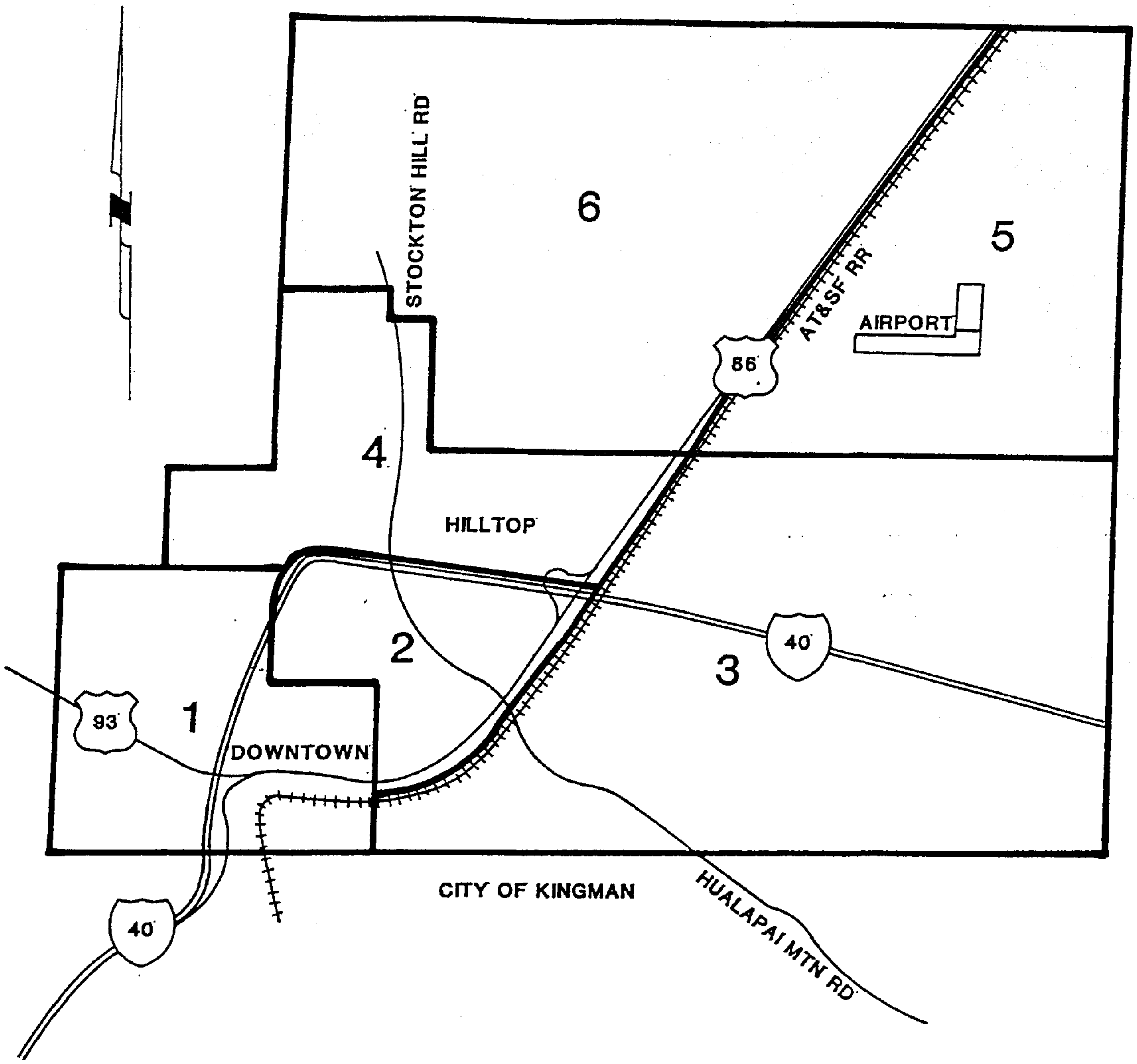
Area Four - Centennial Area Area north of Interstate 40, west of Route 66.

Area Five - Airport Area Area north of Interstate 40, east of Route 66.

Area Six - Camelback/Butler Area North of Hilltop Area, west of Route 66.

PROJECT METHODOLOGIES AND LIMITATIONS

A substantial portion of this report is based upon research of City files and records and discussions with City staff. While care has been taken to validate this information whenever possible, analyses and recommendations can only be relied on to the extent the underlying information is accurate. Therefore, the City is encouraged to update statistical information presented in this report on a regular basis to ensure decisions are based on accurate and current data.



GENERAL PLAN NEIGHBORHOOD PLANNING AREAS

1. Downtown and West Hwy 93 Areas
2. Central Hilltop and Country Club Areas
3. East Kingman Area
4. Hilltop North Area
5. Airport Area
6. Butler and Peripheral Areas

EXHIBIT 1-1

WILLDAN ASSOCIATES
MUNICIPAL ENGINEERS

A basic component of reviews of this nature is the data base of individual customer consumption. Typically, this data is maintained on-line in the computer system which supports customer service, or historical magnetic tapes are stored which can be utilized to develop the information through special programs. Neither of these sources of information were available for this review. Therefore, a twelve-month data base of information was manually developed using water consumption reports and listings of customers for the period October 1991 through September 1992 in various classifications. This manually developed data base was reconciled to other production and financial information; no inconsistencies were noted. Therefore, the manually developed data base appears to accurately represent the actual consumption activity of the company.

There are two components included in the manually developed data base:

Large meter customers These are customers with meters one inch or larger, regardless of type of water use. A review of meter reading books was made to obtain individual water consumption information for each large meter customer. Additional information regarding customer type was obtained using sewer classification information (where available) or other analyses.

Small meter customers These are customers with 5/8" x 3/4" meters (typically referred to as 3/4" meters), regardless of type of water use. Since approximately 97% of the water system's customers have small meters, it wasn't feasible to develop a history of all customer accounts. Therefore, it was decided to develop a history for a sample of these accounts. The most reliable and accessible source of information for customer water usage is the meter reading books. The account numbering system used in these books, while it serves the purposes of the City, is not in a sequential manner, and cannot be used for direct random sampling. A cluster sampling approach was taken, whereby accounts were selected from a specific location in each meter book; if the account occurring at that location was a large meter, it was discarded and the next available small meter account was selected. To provide a confidence level of 95%, a sample of 175 accounts was required. This sample was exceeded, and 270 accounts were actually selected. Thus, the small meter water usage information cited in this report can be considered accurate 95% of the time, plus or minus 2.5%. Sampling results were compared to other water production and usage and production information to further ensure reliability.

A significant amount of financial and engineering data has been considered in developing this report and water conservation program. Willdan Associates has relied on City of Kingman personnel to provide some of the financial and engineering data incorporated in this report. In addition, consumption and cost projections employed in this report should not be construed as statements of fact. The accuracy of any forecast is dependent upon the occurrence of future events which cannot be assured.

ORGANIZATION OF REPORT

The remainder of this report is organized into six chapters and an appendices. The contents of the chapters are as follows:

Chapter Two - Water Demand Analysis, which includes the demand analysis study methodology, an analysis of water service providers, a review of consumption for existing water users, classification by geographic area, classification by user type, a review of project area development, land use alternatives population growth alternatives, land development models, water consumption alternatives, and a water demand model.

Chapter Three - Groundwater Analysis, which includes the groundwater analysis study methodology, a summary of the hydrogeologic report, an analysis of existing groundwater usage and availability, projection of additional groundwater resources, and a database of registered wells within the project study area. A complete hydrogeologic report is included as an appendix to this report.

Chapter Four - Water Resource Alternative Development This chapter analyzes groundwater as a resource, Colorado River water as a resource, effluent reuse as a resource, and

stormwater capture as a resource.

Chapter Five - Water Conservation Plan - This chapter evaluates existing water conservation efforts and proposes a general conservation plan for all water users as well as a residential conservation plan and commercial conservation plan for those specific customer groups.

Chapter Six - Evaluation of External Factors This chapter evaluates the various external factors impacting water resource management, including legal factors, regulatory factors, environmental factors, political factors, and institutional factors.

Chapter Seven - Economic Feasibility Analysis This chapter evaluates the costs of obtaining water resources, including water system capital construction costs, wastewater system capital construction costs, mitigation costs, legal costs and financing alternatives

Appendices to this report include the hydrogeologic consultant's report, buildout water requirement models, and the well database. Included in a separate volume are various federal and state regulations, model ordinances and resolutions, and water conservation literature.

GLOSSARY

Numerous terms and abbreviations are defined within the body of this report. However, certain terminology which is both sensitive to the interpretation of this report and easily misunderstood is defined in this section:

active account a customer account which, according to City records, services a property which is currently occupied or in use.

inactive account a customer account which, according to City records, services a property which is currently unoccupied or not in use.

billed water usage metered or unmetered water usage which is billed to a customer; most water usage falls within this category.

unbilled water usage metered or unmetered water usage which is not billed to a customer; water usage which falls within this category includes fire suppression, repairs, hydrant flushing, etc. This category is sometimes referred to as "accounted for lost water."

lost water unmetered water usage which is not billed and which cannot usually be attributed to a specific usage. Lost water is quantified as follows:

Water produced minus billed usage minus unbilled usage

= lost water

planning area or project area the area, as defined by the City's general plan and City staff, which was analyzed for existing water usage, water production potential, and future water requirements. This area includes all the properties currently within the City limits as well as areas outside the City limits which may someday be part of the incorporated City limits or in its water service area.

ACKNOWLEDGEMENTS

Willdan Associates appreciates the cooperation and enthusiasm of all City of Kingman staff members during preparation of this report. Individuals who should be specifically recognized include Lou Sorensen, Dennis Roberts, Pete Johnson, Ed Covington, Jack Kramer, Jim Jordan, Coral Lloyd, Paul Langlois, Tom Duranceau, Lana Keller, and Sally Werner. The cooperation and dedication of these staff members has been greatly appreciated, and has been of invaluable assistance during this project.

CHAPTER TWO

WATER DEMAND ANALYSIS

DEMAND ANALYSIS STUDY METHODOLOGY

A basic component of studies of this nature is the development of a reliable database of individual customer consumption. As discussed in Chapter One, this consumption database was developed using actual meter readings for the past two years.

There are two components included in the manually developed data base:

Large meter customers These are customers with meters one inch or larger, regardless of type of water use. A review of meter reading books was made to obtain individual water consumption information for each large meter customer. Additional information regarding customer type was obtained using sewer classification information (where available) or other analyses.

Small meter customers These are customers with 5/8" x 3/4" meters (typically referred to as 3/4" meters), regardless of type of water use.

This water consumption information was further analyzed by geographic area, based upon meter reading "books". The City maintains approximately 80 meter reading books, each of which includes accounts in a specific geographic area. These books were assigned to the planning area in which they were primarily located. As discussed in Chapter One, the City has established six planning areas in The City of Kingman General Plan as follows:

Area One - Downtown Area Original townsite area, primarily north of Andy Devine

Area Two - Hilltop Area Area east of Stockton Hill Road.

Area Three - Hualapai Mountain Area Area east of Andy Devine, extending north to the Township 21 boundary.

Area Four - Centennial Area Area north of Interstate 40, west of Route 66.

Area Five - Airport Area Area north of Interstate 40, east of Route 66.

Area Six - Camelback/Butler Area North of Hilltop Area, west of Route 66.

City utility billing registers were further analyzed to develop information regarding the general user classification of accounts. Water production and unbilled usage information was reviewed to determine its impact on total water demand. Although minor differences occur in the various information sources, general cohesiveness and correlation was noted.

WATER SERVICE PROVIDERS IN KINGMAN AREA

In conjunction with a review of City water system data, a review was made of other water providers in the Kingman area. Information relative to the following private water companies/districts were reviewed:

Walnut Creek Water Company, Inc.

Valley Pioneer's Water Company, Inc.

Cerbat Water Company

Lake Juniper Water Company, Inc.

So-Hi Domestic Water Improvement District

A search of Arizona Corporation Commission annual reports revealed the following information:

Cerbat Water Company, Inc.: This system owns one large producing well and has 36,000 gallons of storage capacity. It utilizes approximately 50,000 feet of water lines to serve its 51 customers. In 1991 the system sold over six million gallons of water, or about 9,700 gallons monthly per customer connection.

Valley Pioneer's Water Company, Inc.: This system owns three wells, which have a combined yield of 440 gallons per minute and has 776,000 gallons of storage capacity. It utilizes approximately 308,000 feet of water lines to serve its 1,700 customers. In 1991 the system sold over 103 million gallons of water. Many of the customers using this system are water haulers dependent on cisterns.

Walnut Creek Water Company, Inc.: This system owns three wells, which have a combined yield of 100 gallons per minute and has 315,000 gallons of storage capacity. It utilizes approximately 40,000 feet of water lines to serve its 61 customers. In 1991 the system sold over 4.5 million gallons of water, or about 6,000 gallons monthly per customer connection. A large portion of water service is being provided by the City of Kingman pursuant to an agreement with the water utility company.

Lake Juniper Water Company: This system is essentially inactive and has no recorded water usage information at the Arizona Corporation Commission.

So-Hi Domestic Water Improvement District: This system has a 40 year lease with the City of Kingman for a well which provides the district with all water consumed by its customers. No information was available regarding water usage.

In addition, some properties within the project area are served by privately owned wells. This information is generally not reported or available for inclusion in our demand analyses.

ANALYSIS OF LARGE METER WATER USERS

The City has approximately 270 large meter water users. Water consumption for the period October 1991 through September 1992 was obtained for all of these customers. The following observations are made:

Analysis of all large meter customers Exhibit 2-1 presents the average monthly water usage of these customers. The peak usage for these customers occurs in the months of July through September, when usage exceeds 200,000 gallons per month. Low usage months are January through March, when consumption drops below 80,000 gallons per month. Exhibit 2-2 presents the average monthly usage for various size meters:

1" meter The peak and low months for these customers are the same as the entire group, but the variance isn't as wide. Peak usage occurs in September with 110,000 gallons and the low month is January with approximately 40,000 gallons.

1 1/2" meter Water consumption for these customers is relatively stable, ranging from 90,000 gallons in August to 50,000 gallons in March.

2" meter The shape of the curve for these customers is almost identical to the entire group. Peak usage occurs in August (250,000 gallons) and the low month is March (110,000).

3" meter The consumption pattern of this group is similar to the entire group pattern, with some irregularities noted; these can probably be attributed to the small size of the group and the resulting inability to "smooth" averages. The peak month is July (360,000 gallons) and the low month is February (150,000).

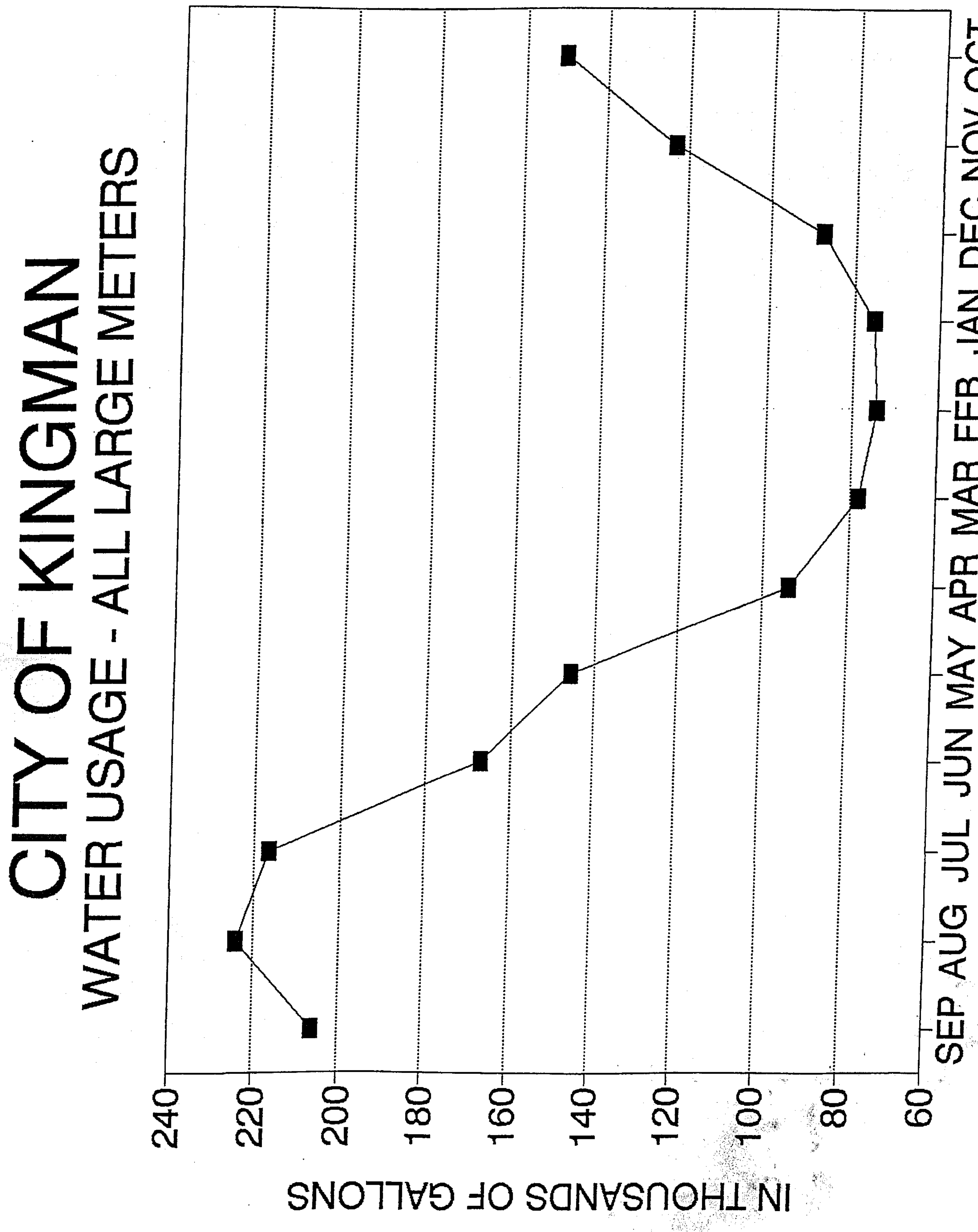

CITY OF KINGMAN
WATER USAGE - ALL LARGE METERS
IN THOUSANDS OF GALLONS
240
220
200
180
160
140
120
100
80
60
SEP AUG JUL JUN MAY APR MAR FEB JAN DEC NOV OCT

EXHIBIT 2-1

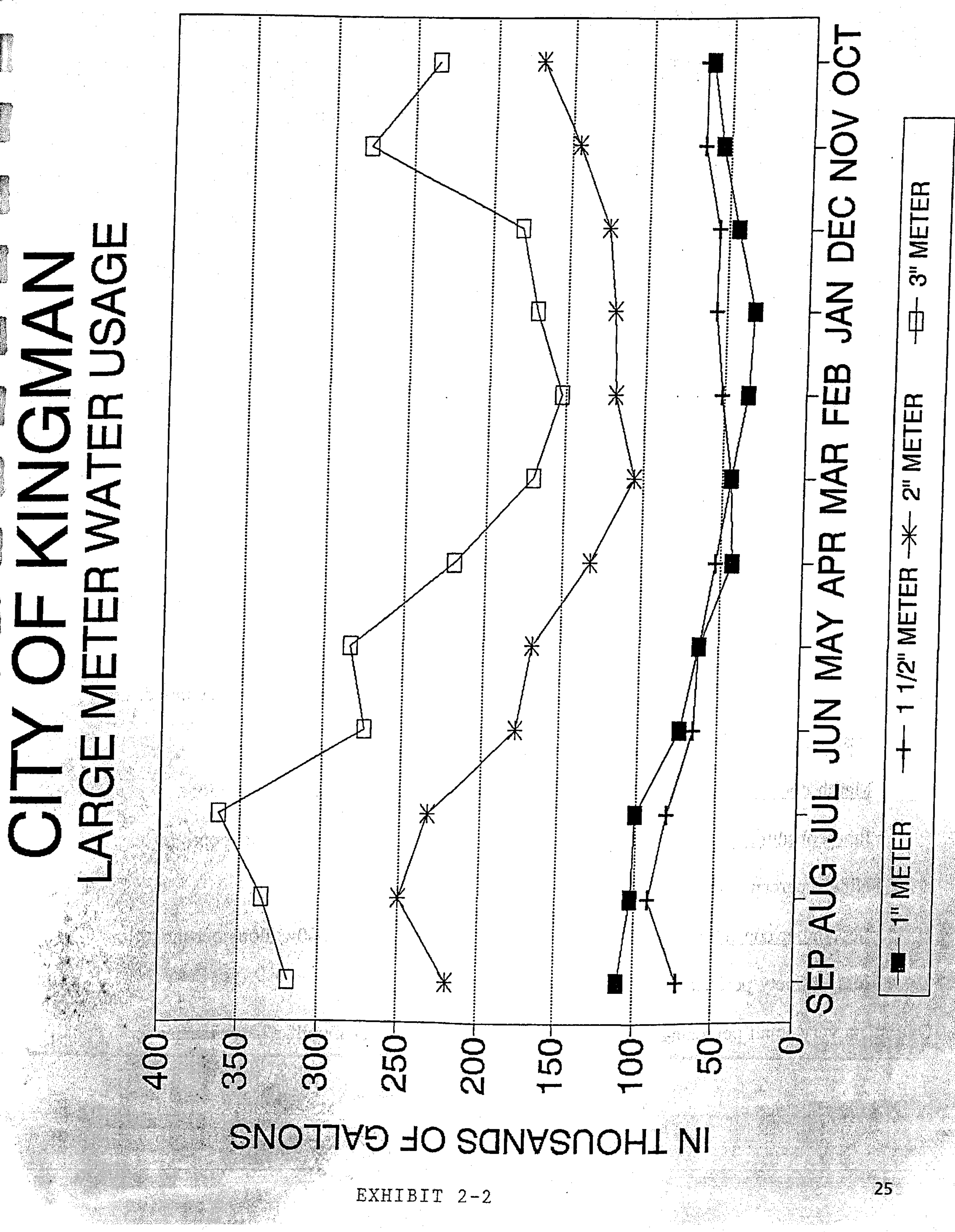

CITY OF KINGMAN
LARGE METER WATER USAGE
IN THOUSANDS OF GALLONS
400
350
300
250
200
150
100
50
0
SEP
AUG
JUL
JUN
MAY
APR
MAR
FEB
JAN
DEC
NOV
OCT
1" METER
1 1/2" METER
2" METER
3" METER

EXHIBIT 2-2

4" and 6" meters The consumption patterns of these groups were not graphed due to the small number of meters and the wide variance in consumption.

The water conservation potential of customers in these categories will be discussed in Chapter Five.

ANALYSIS OF SMALL METER USERS

As previously noted, approximately 97% of the City's customers have small meters (5/8" x 3/4"). A representative sample was obtained of these customers, and the results are presented in Exhibits 2-3 through 2-7. Consumption is classified by thousands of gallons per month, using "consumption blocks" for the higher volume stratifications. For example, the customers identified in the consumption block "50,000" use 41,000 to 50,000 gallons of water. The percentage of customers is cumulative. For example the percentage of customers in a given consumption block includes that block and all preceding blocks. The following observations are noted:

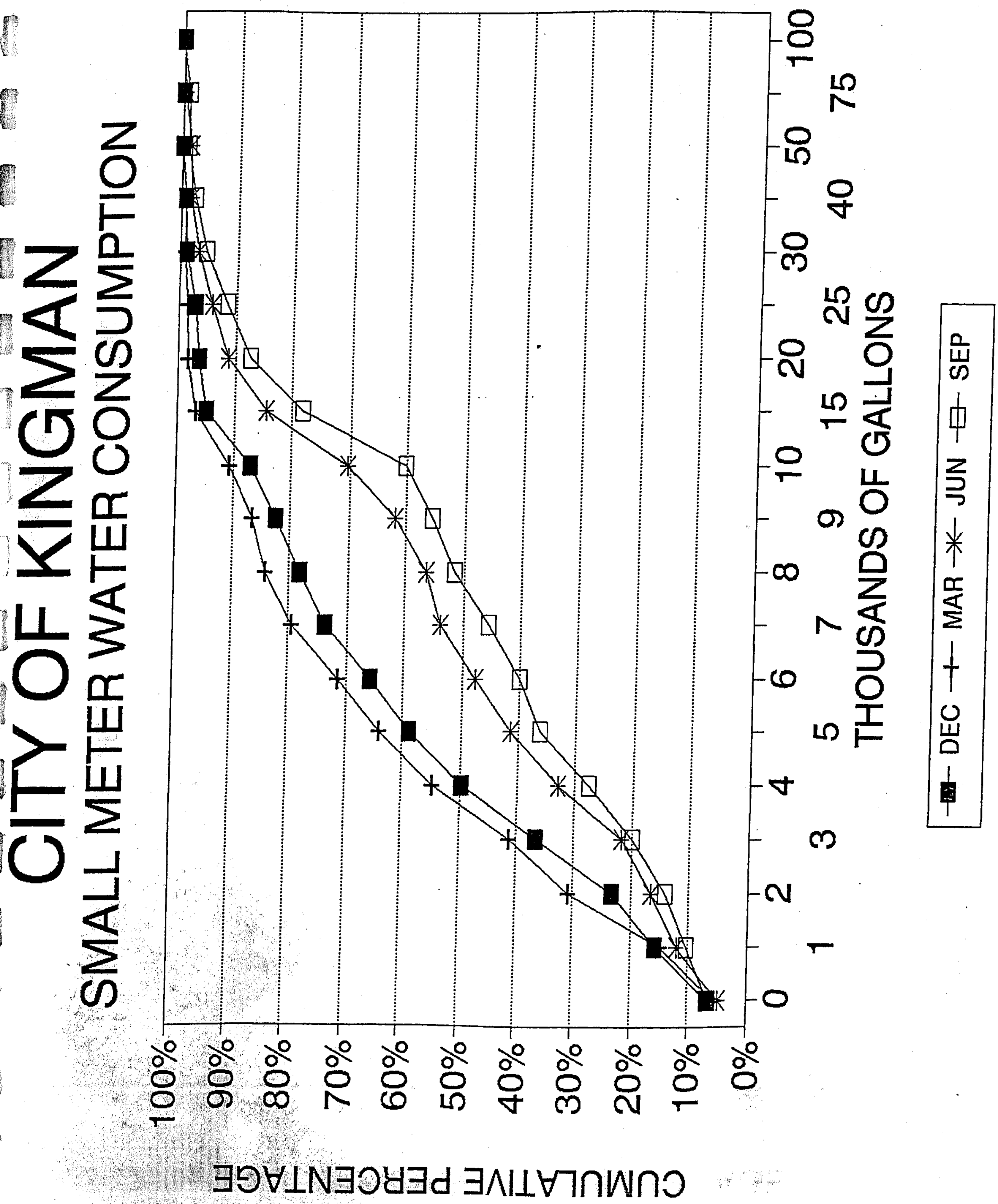
December consumption Fifty percent of the customers use 4,000 gallons per month or less. Ninety percent use 10,000 gallons per month or less.

March consumption The pattern is almost identical to December consumption.

June consumption Fifty percent of the customers use 6,000 gallons per month or less. Ninety percent use 15,000 gallons per month or less.

September consumption Fifty percent of the customers use 8,000 gallons per month or less. Ninety percent use 20,000 gallons per month or less.

Overall, a very small percentage use more than 30,000 gallons per month. This is reflected in



CITY OF KINGMAN
SMALL METER WATER CONSUMPTION
CUMULATIVE PERCENTAGE
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
1
2
3
4
5
6
7
8
9
10
15
20
25
30
40
50
75
100
THOUSANDS OF GALLONS
DEC
MAR
JUN
SEP

EXHIBIT 2-3

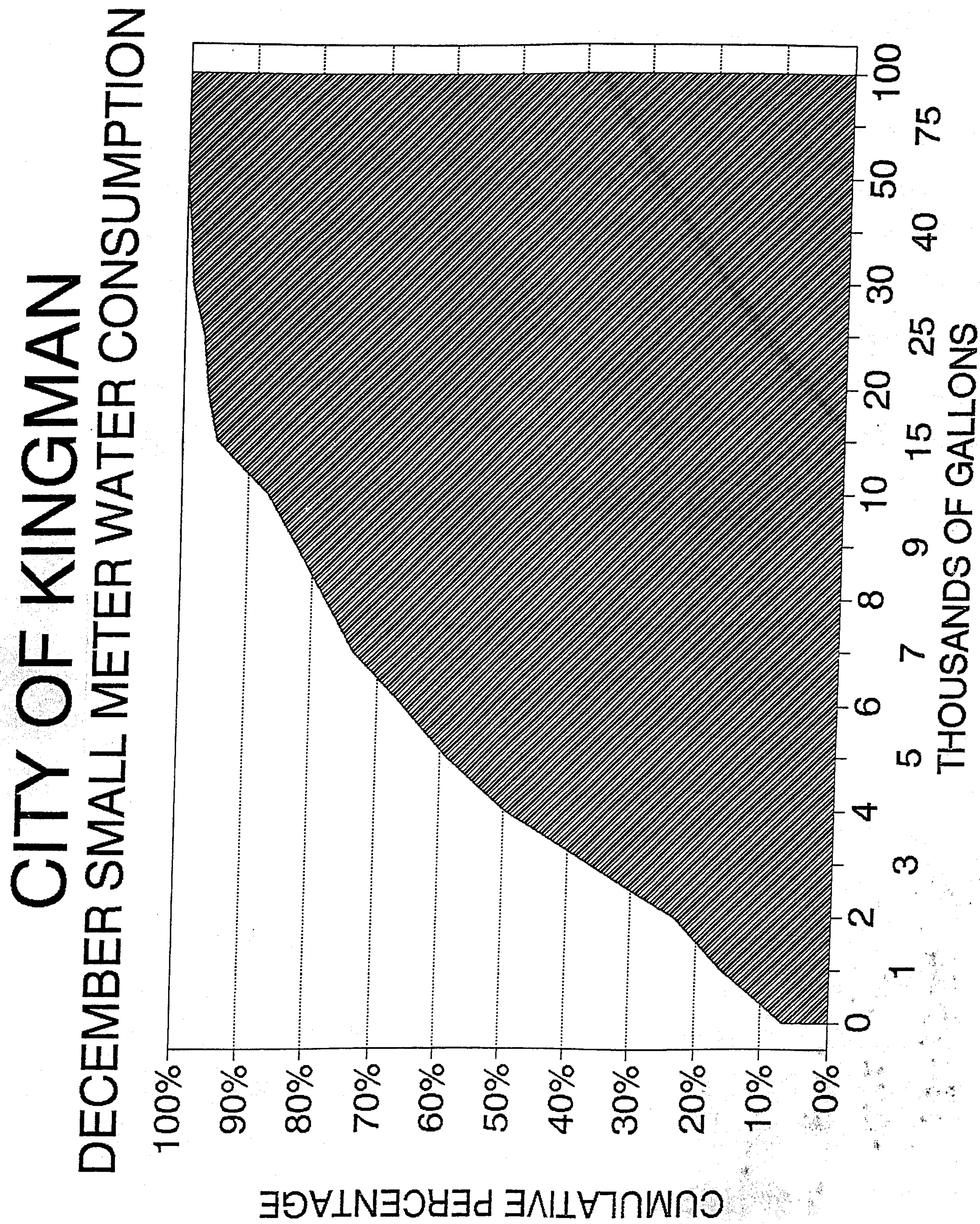

CITY OF KINGMAN
DECEMBER SMALL METER WATER CONSUMPTION
CUMULATIVE PERCENTAGE
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
0
1
2
3
4
5
6
7
8
9
10
15
20
25
30
40
50
75
100
THOUSANDS OF GALLONS

EXHIBIT 2-4

CITY OF KINGMAN

MARCH SMALL METER WATER CONSUMPTION

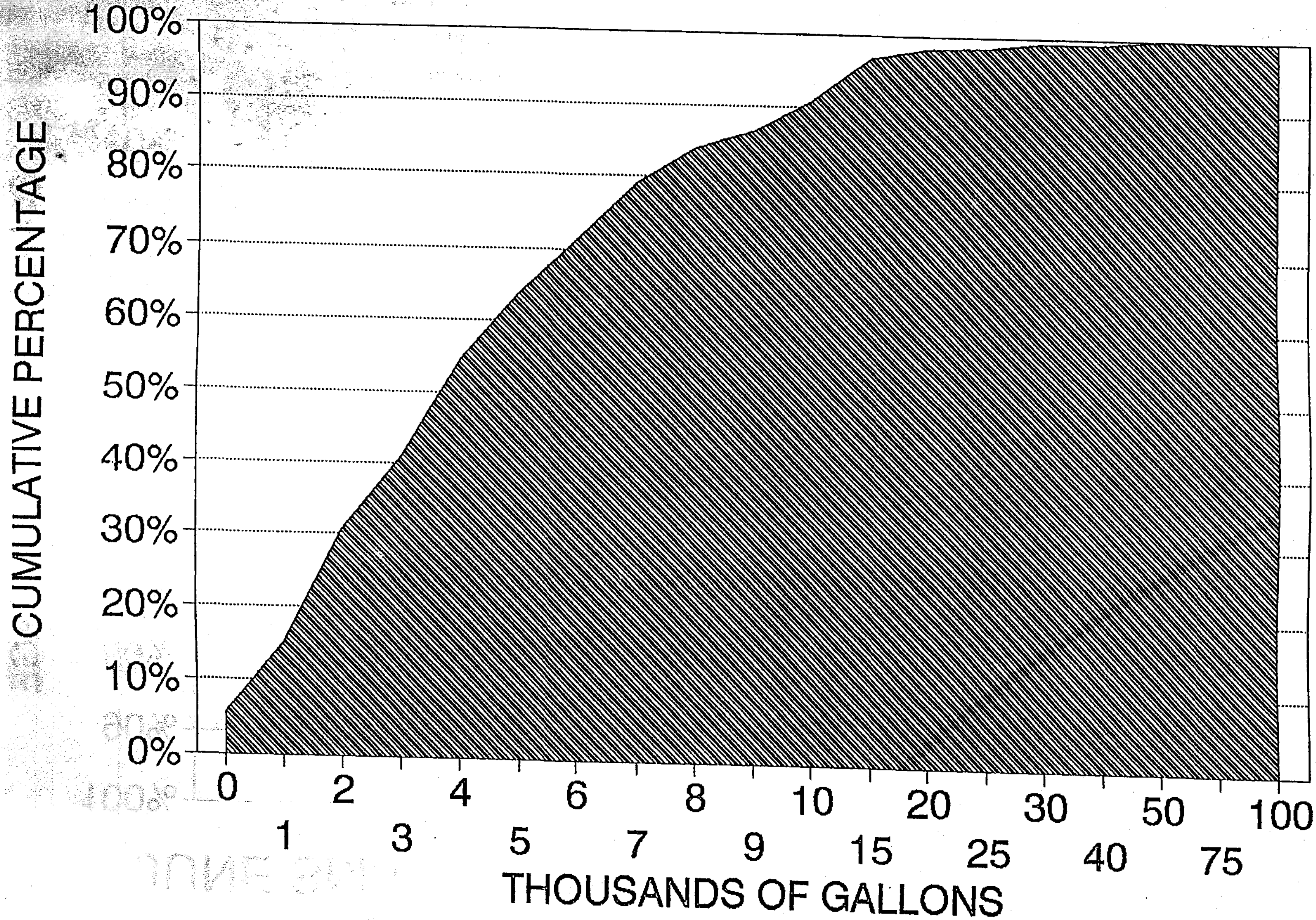


EXHIBIT 2-5

CITY OF KINGMAN
JUNE SMALL METER WATER CONSUMPTION

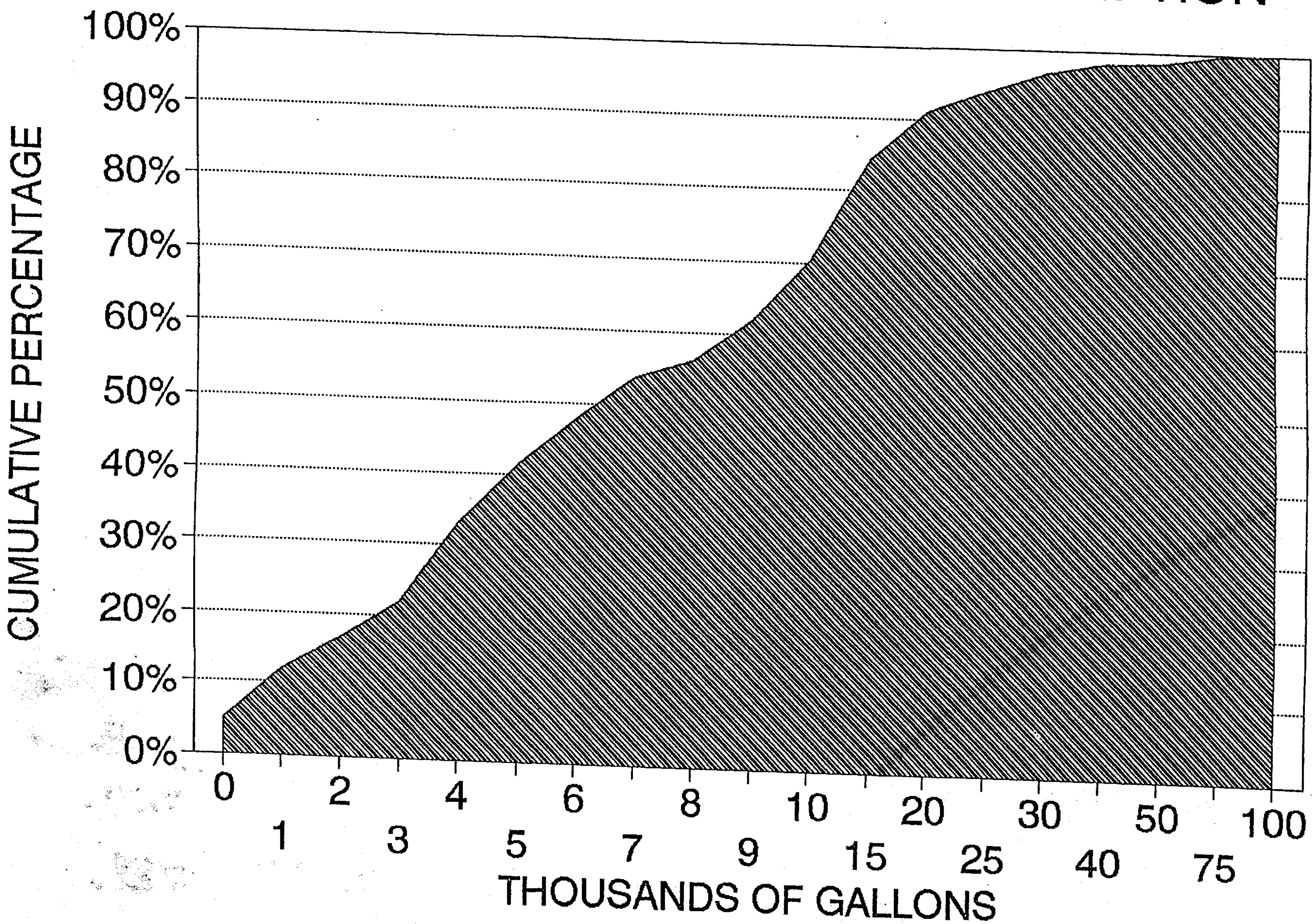


EXHIBIT 2-6

CITY OF KINGMAN

SEPTEMBER SMALL METER WATER CONSUMPTION

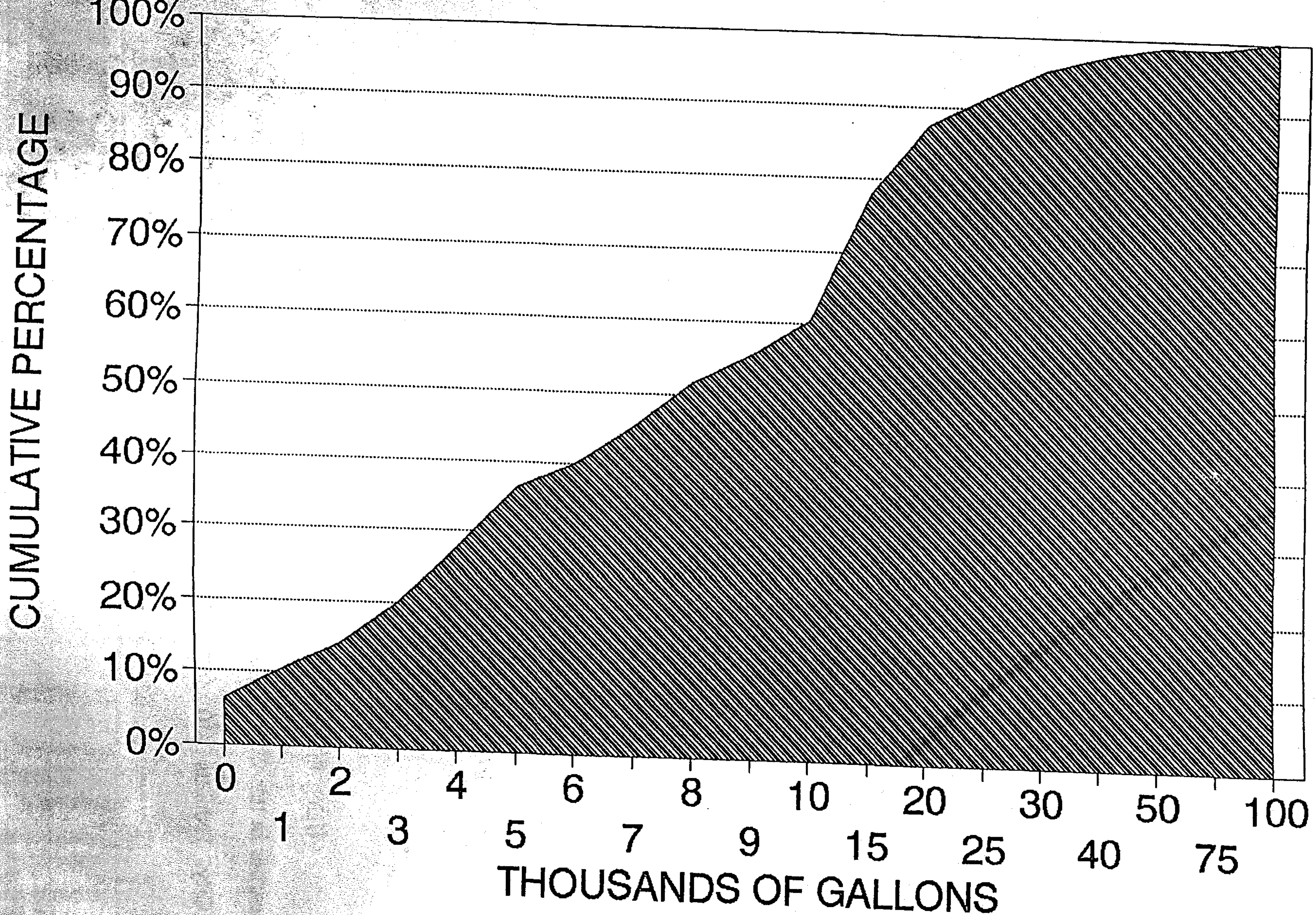


EXHIBIT 2-7

the City's overall 173 gallons per capita per day usage rate. The water conservation potential of customers in these categories will be discussed in Chapter Five.

ANALYSIS BY CUSTOMER TYPE

Exhibits 2-8 and 2-9 present the type of customer, according to the City's customer classification system of residential, commercial, and public users. This information is also presented by planning area, which will be discussed in the next section of this chapter. The following is noted:

Residential customers Over 90% of all water customers are residential water users. This category includes single family residences as well as duplexes, and multi-family residential complexes.

Commercial customers Over 8% of all water customers are commercial water users. This category is comprised of all customers who are either not residential or public users.

Public customers Less than two percent of all water customers are public water users. This category is comprised of all governmental water users, including parks and open space irrigation customers.

ANALYSIS BY GEOGRAPHIC AREA

Using the planning areas identified by the City's general plan (which were discussed earlier in this Chapter), an analysis was made of water consumption by geographic area of the City. Exhibits 2-10 and 2-11 present the results of this analysis. The following is noted:

Downtown area This area uses on average 13.47% of all water consumed in the City.

CITY OF KINGMAN
WATER ADEQUACY STUDY
ACCOUNTS PER PLANNING AREA

AREA	RESID.	COMM.	PUB.	TOTAL
DOWNTOWN	820	204	52	1076
HILLTOP	1753	199	15	1967
HUALAPAI MT.	889	56	16	961
CENTENNIAL	1813	257	28	2098
AIRPORT	146	67	0	213
CAMELBACK/BUTLER	4455	110	17	4582
TOTALS	9876	893	128	10897

EXHIBIT 2-8

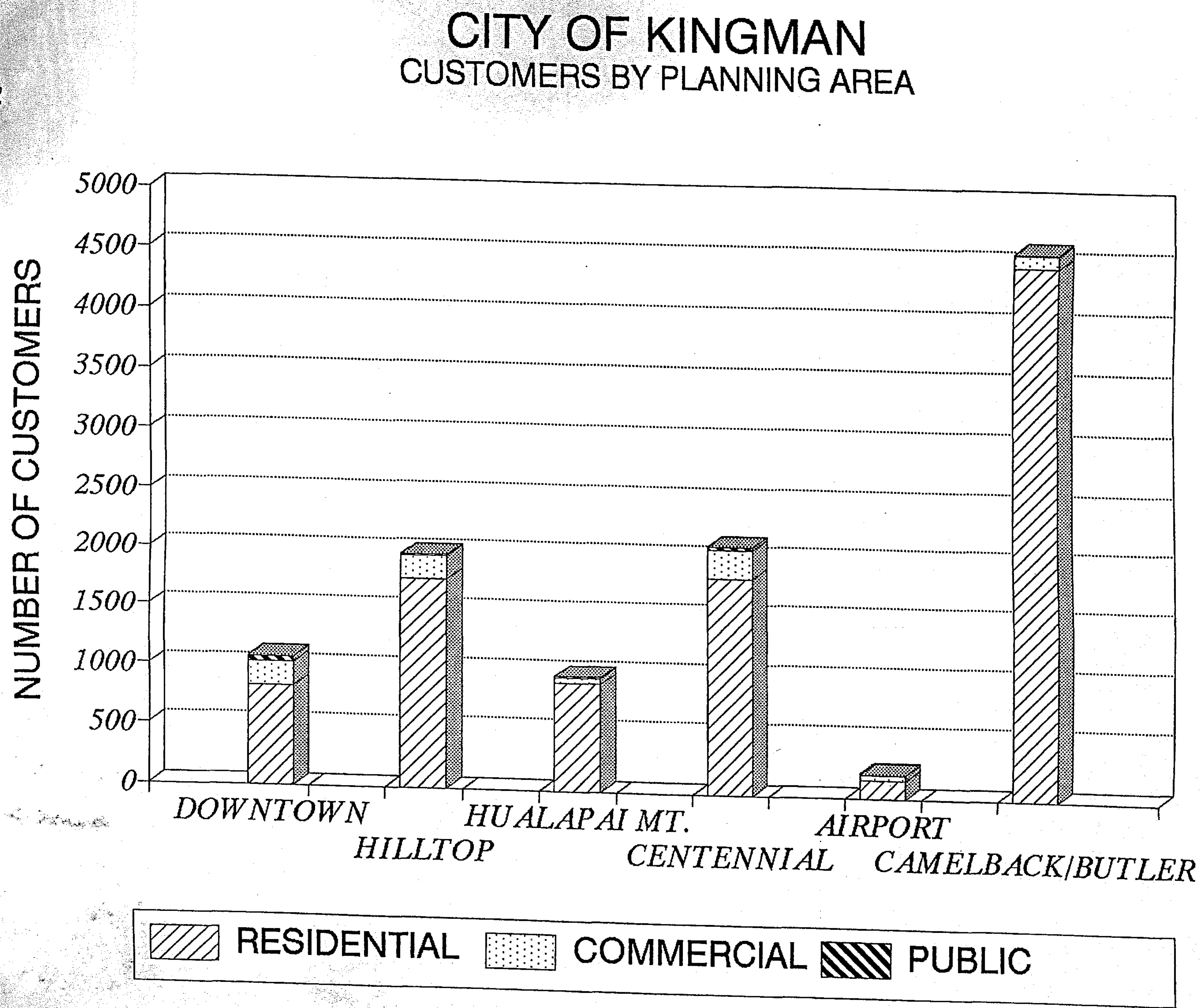

CITY OF KINGMAN
CUSTOMERS BY PLANNING AREA
NUMBER OF CUSTOMERS
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
DOWNTOWN
HILLTOP
HUALAPAI MT.
CENTENNIAL
AIRPORT
CAMELBACK/BUTLER
RESIDENTIAL
COMMERCIAL
PUBLIC

EXHIBIT 2-9

WATER CONSUMPTION PER PLANNING AREA
SELECTED MONTHS IN 1992

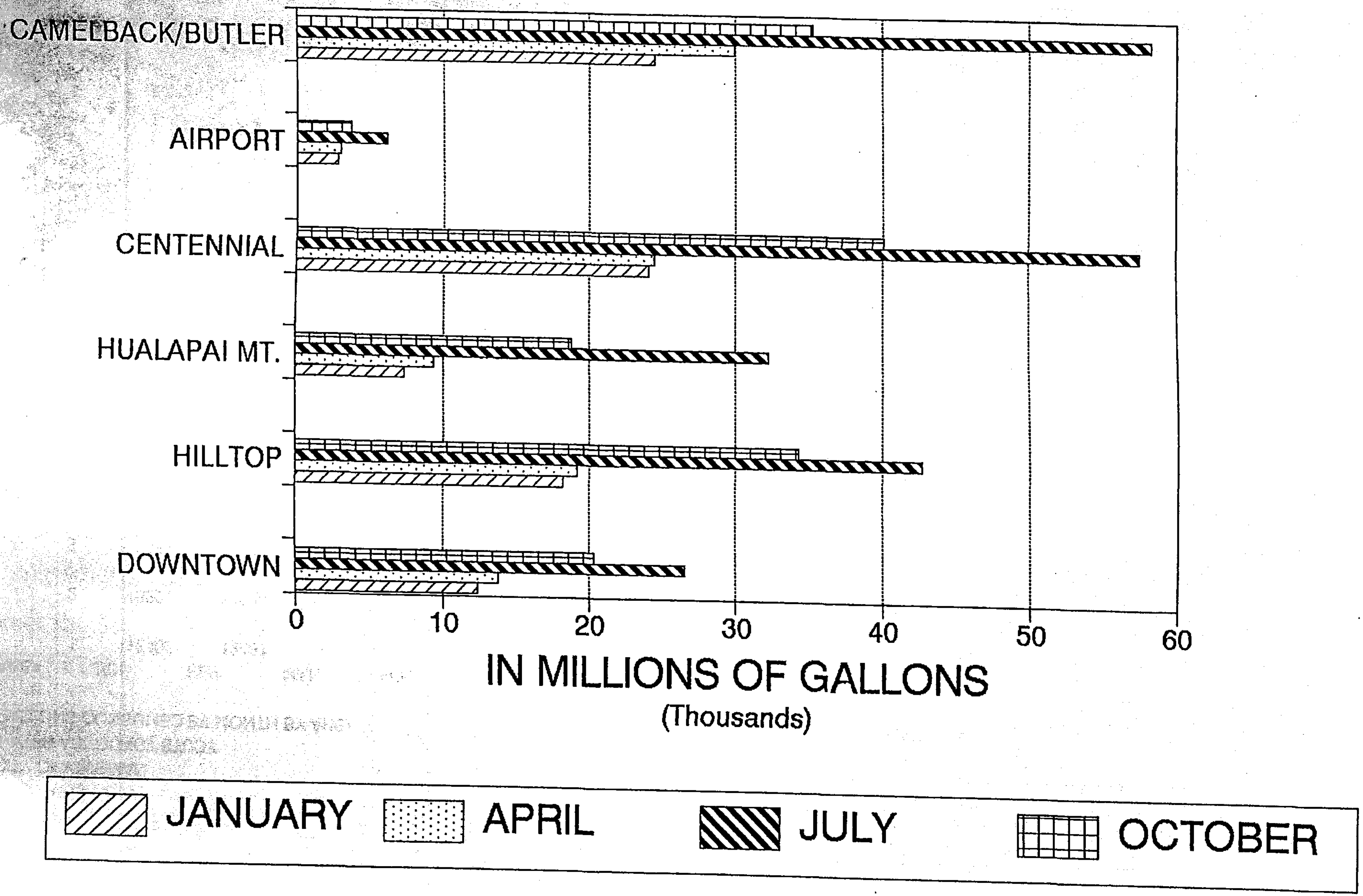


EXHIBIT 2-10

CITY OF KINGMAN
WATER ADEQUACY STUDY
GALLONS CONSUMED BY MONTH BY AREA

AREA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVG	
1	12402	12437	11753	13804	20670	20558	26543	28897	25592	20273	19071	15740	18978	13.47%
2	18201	17084	15693	19208	28281	30393	42771	39408	38181	34306	26889	18286	27392	19.44%
3	7354	7662	8181	9456	20013	24162	32265	30544	27231	18757	13657	8746	17336	12.30%
4	24081	24083	20579	24521	39190	41633	57641	58966	54296	40092	33344	25279	36975	26.24%
5	2792	2205	1931	2976	3670	4663	6137	5514	5412	3731	3523	2435	3749	2.66%
6	24504	23360	22167	29900	37620	54021	58291	49799	49425	35319	26803	26390	36467	25.88%
TOTAL	89334	86831	80304	99865	149444	175430	223648	213128	200137	152478	123287	96876	140897	100.00%

EXHIBIT 2-11

It has 9.87% of the water system's customers.

Hilltop area This area uses on average 19.44% of all water consumed in the City. It has 18.05% of the water system's customers.

Hualapai Mountain area This area uses on average 12.30% of all water consumed in the City. It has 8.82% of the water system's customers.

Centennial area This area uses on average 26.24% of all water consumed in the City. It has 19.25% of the water system's customers.

Airport area This area uses on average 2.66% of all water consumed in the City. It has 1.95% of the water system's customers.

Camelback/Butler area This area uses on average 25.88% of all water consumed in the City. It has 42.04% of the water system's customers.

As can be observed, there is not necessarily a correlation between the amount of water used and the number of customers in a given area.

PROJECTED AREA DEVELOPMENT

A key element of the water demand analysis is the ability to accurately project planning area development, which ultimately becomes the build-out service area. Current demographics will generate real-time consumption patterns among the various user groups. This "snapshot" will provide the baseline data from which future projections can be made.

Not only is the type of development, i.e. single-family residential, multi-family residential, irrigation, commercial, industrial or governmental, important; but consideration must also be given to when and where development occurs.

The best "blueprint" available for planning purposes is the Kingman General Plan which was adopted by the City Council on May 4, 1992. Kingman has historically been a major hub for transportation, commerce and government administration. More recently, Kingman has been experiencing growth in its recreational and residential sectors, due in part to increased gaming activities along the Colorado River. Site-specific commercial and industrial potential is also being nurtured through concerted efforts of the Mayor, City Council, the Kingman Resource Group, the Kingman 2005 Group and the Chamber of Commerce. Some of this new growth may be water-use intensive. In addition, efforts in business retention are also underway. Consumption patterns for existing businesses have been quantified as part of this study.

At the City's Industrial Park near the Kingman Airport, there are no real water intensive users currently. Based on information provided by the Airport Authority, there are approximately five employees, per acre, on average spread over the already developed 500 acres. Build-out of the remaining 2500 acres is anticipated to occur between 2003 and 2010. The type of future development will be consistent with the light manufacturing and distribution focus now in place. Some heavy manufacturing is possible, if environmentally acceptable. Air traffic safety is a critical consideration in development location. Activities that impair visibility or attract birds are not conducive to siting at the Industrial Park.

Other potential land use in proximity to the Industrial Park, but not necessarily tied to the Park itself, includes possible construction of a hotel/convention center/golf course complex. This type of use is water intensive, but does provide the opportunity for reclamation of wastewater. Turf irrigation needs can be met with reclaimed water. Other wastewater uses could include: fire suppression, industrial cooling and construction-related compaction and dust control. Separate gray water systems would be required, however. Currently, there is no state or local authorizing legislation which provides comprehensive governance of grey water system construction and operation. Enabling legislation may be required, if an aggressive reuse program were implemented.

The success of the General Plan is reflected in not only the desire to attract new industrial and commercial development, but also, in the acknowledgement that retention of existing businesses is an equally important element. The current consumption patterns of Kingman's non-residential sector reflects a stable, and not real intensive, water usage.

Given current and planned commercial and industrial activity, expanded retail trade is expected. This, in turn, will affect the residential demographics. Newer single-family residences will be built, with more modern, water using appliances (garbage disposals, water softeners/purifiers, washers) and amenities (swimming pools, spas and increased landscaping).

The City, through its General Plan, has created a "vision", or "image", for the future which is manifest in a low density urban form that is sensitive to the environment.

Even though the General Plan is for the period 1990-2010, this Water Resources Study extends its projections out to 2095. Exhibit 2-12 presents, in five year increments, population projections for the City at the 1.0%, 2.8%, 4.0% and 5.0% levels.

LAND USE ALTERNATIVES

The various land use alternatives will depend on the factors which are itemized in the General Plan: mountains and flood zones, infrastructure (water, sewer and streets) location, restricted access to areas east of the railroad tracks, old subdivisions and standardized lots and

Interstate 40.

Population projections, coupled with land use acres, will provide the necessary consumption patterns and maximized demand parameters. At build-out, it is projected that the planning area "maximum potential population" will reach 325,086. It is prudent methodology to subtract from this figure, per acre development that is expressly set aside for streets, roads and rights-of-way requirements. This reduction is estimated to be ten percent (10%), or 32,509. For water resources planning purposes, the build-out population maximum population is 292,577. Various population growth scenarios were calculated using percentage increases consistent with the General Plan.

The City's criteria for development focuses on prime retail, commercial clusters, continuation as a governmental center and recreation. Water usage analysis was completed for each of the specific activities.

ADDITIONAL LARGE WATER USERS ADDED TO THE SERVICE AREA SHORT-TERM.

In October of 1992, the 156 unit Copper Ridge Apartment Complex came on-line. This facility will provide excellent insight as to multi-family residential water usage in the short-term. The new Kingman High School is scheduled to open in August of 1993. Student enrollment is estimated to be 800 initially, and over 1400 at build-out. Wal-Mart is planning to construct a retail facility, which is scheduled to be open for business in the fall of 1993. Depending on the type of inventory, stock and service provided, this may be a large water user. Anticipated spin-off development around Wal-Mart can be expected.

Within the next three years, another nine holes will be added to the Kingman Municipal Golf Course. As previously mentioned, an eighteen hole golf course could be constructed as part of a resort/convention center complex.

CONSUMPTION AND WATER DEMAND ALTERNATIVES

In determining the various consumption alternatives, this study has used a worst-case, best-case, midline-case approach. Distribution/delivery system improvements, conservation, augmentation and reuse are all components of a comprehensive plan. The consumption alternatives thus developed were based on the aforementioned growth alternatives of 1.0%, 2.8%, 4.0% and 5.0%. They were applied against the following gallons per capita per day (GPCD) factors:

173 GPCD This is the current consumption rate of the City, and could be maintained if no changes were made in consumer or land use compositions.

190 GPCD This is the "worst case" consumption alternative of the City, which is a ten percent increase over existing consumption.

147 GPCD This is the "best case" consumption alternative of the City, which is a fifteen percent decrease from existing consumption.

156 GPCD This is the "next best case" consumption alternative of the City, which is a ten percent decrease from existing consumption.

Methods for achieving these conservation levels will be presented in Chapter Five of this report.

Exhibit 2-12 presents the cumulative overdraft of the groundwater for each of these alternatives. As presented in Chapter Three, the City has over 4.5 million acre feet of groundwater available from the upper Hualapai Basin. Assuming, as a policy decision, the City does not wish to exceed 3.0 million acre feet of overdraft, the groundwater supply is sufficient for all growth alternatives, assuming some conservation is achieved at the 4.0% and 5.0% growth rates. The rationale for this decision is that sound water resource management dictates that the Kingman groundwater supply should not be totally depleted. The 1.5 million acre feet balance can be used as a reserve or emergency supply should planning circumstances dictate a response other than what is developed from this study. In addition, water quality concerns and energy related costs of pumping from lower depths are factors which would support the notion that the City should not plan, under normal conditions, on utilizing all 4.5 million acre-feet available. Volume II of this report includes, in tabular form, all of the information used to develop this graph and analysis. The sixteen models included in this appendix present annual growth through the year 2093, the amount of water required based upon each GPCD, the amount of recharge occurring as a result of this water usage, and the cumulative overdraft on an annual basis. It should be noted that maximum build-out of the City, as defined by the general plan, is not achieved by 2093 if the growth rate is only one percent. For the other growth models, the maximum build-out is achieved, and population is held constant after that time.

It should also be noted that additional groundwater could be developed for use within the planning area from other basins or sub-basins. The Sacramento Basin and Lower Hualapai Basin are good examples. Future City planning activities can include examination of these other potential sources and related cost comparisons.

CITY OF KINGMAN
CUMULATIVE OVERDRAFT IN YEAR 2093

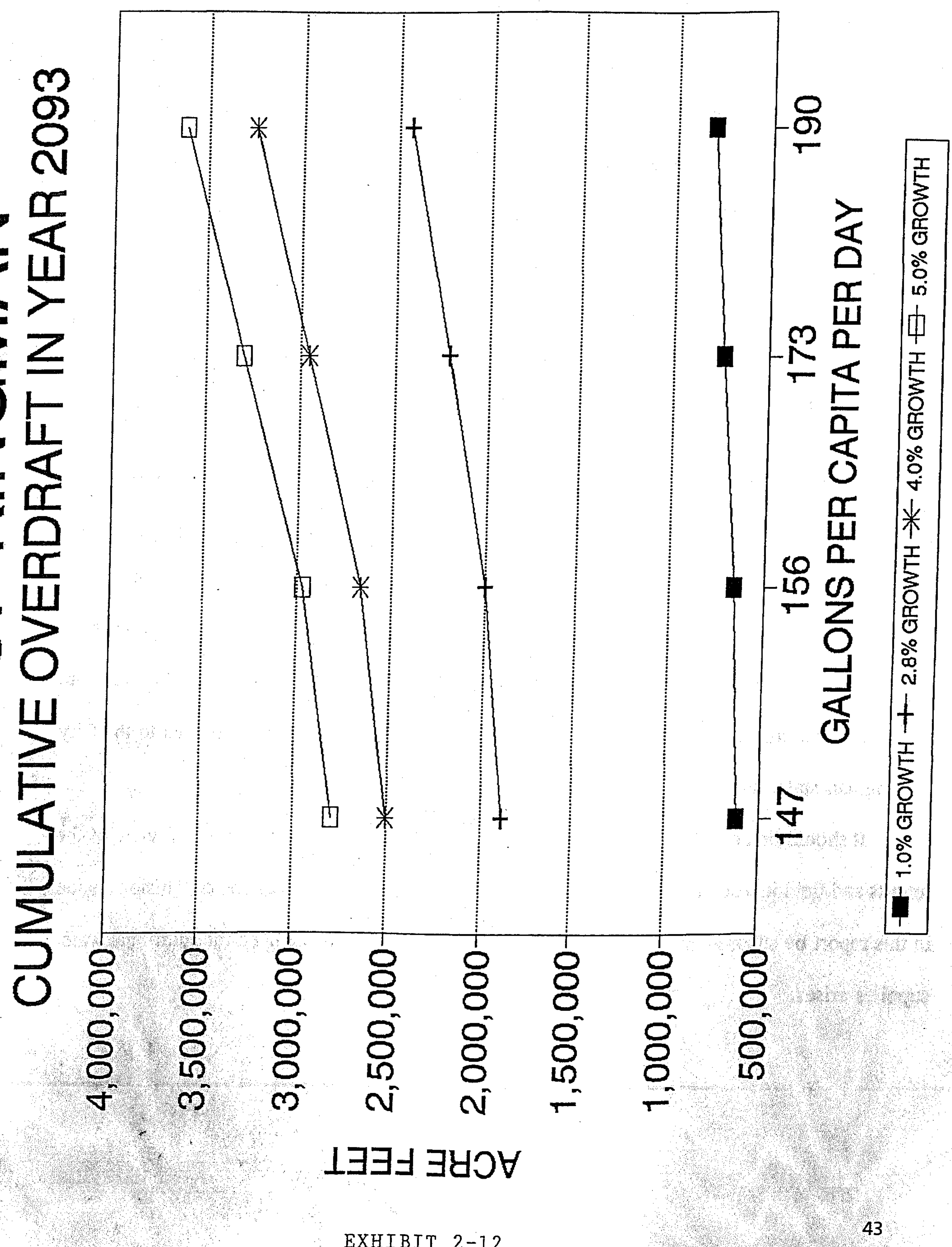


EXHIBIT 2-12

CHAPTER THREE

GROUNDWATER ANALYSIS

GROUNDWATER ANALYSIS STUDY METHODOLOGY

At the present time the City of Kingman is entirely dependent upon groundwater as its source of supply for its potable water system. The following objectives were established in studying the adequacy and characteristics of this water source:

- the location of groundwater as an existing and potential source within the planning area.
- the quantity of groundwater accessible to the City for current and future needs.
- the quality of groundwater accessible to the City for current and future needs.

The groundwater analysis phase of this project was performed by Kenneth D. Schmidt and Associates; Dr. Schmidt is the principal author of the resulting report. The report is appended in its entirety as Appendice A to this report and the reader is directed to that document accordingly. Some of the maps and diagrams in the report have been reduced to facilitate production and copying of this report. Original size documents have been provided to the City of Kingman staff, and should be referred to where detail is desired.

It should be noted that Dr. Schmidt's analysis of this topic is based upon a review of the reports and field investigations of others. It is generally recommended that the conclusions made in this report be subsequently validated with field investigations as the need for additional water supplies arises.

SUMMARY OF GROUNDWATER ANALYSIS REPORT

The following critical observations from the Schmidt report are made:

- City pumping of groundwater has averaged about 4,600 acre feet per year since 1985.

- Non-City pumping of groundwater averages about 400 acre feet per year.

- Total groundwater pumping averages 5,000 acre feet per year.

- Return to recharge groundwater (from sources such as percolation of effluent) is estimated at 1,000 acre feet per year.

- The net overdraft of the aquifer is thus 4,000 acre feet per year.

- The average drawdown of the aquifer has been about one foot per year.

- There is approximately 4.2 million recoverable acre feet in the aquifer.

- If the population were to remain the same as at the present (approximately 26,000), there is a sufficient groundwater supply for over 1,000 years at the current drawdown rate.

- The available groundwater above 1,000 feet is of a sufficient quality for domestic purposes.

- The available groundwater below 1,000 feet may require a certain level of treatment, especially for chromium removal.

- Sufficient supplies exist in the Upper Hualapai Valley. It was not recommended that the City consider obtaining supplies from the Sacramento Valley at this time.

WELL DATABASE ANALYSIS

In addition to the aforementioned groundwater analysis, a review as made of all Kingman area wells registered with the Arizona Department of Water Resources. This analysis revealed that 148 non-City wells are located within the City limits and/or project planning area. A complete listing of these wells is presented in Appendix B of this report. The user composition of these wells is as follows:

Usage Type	Number
Domestic	106
Irrigation/Agricultural	14
Livestock	15
Industrial	7
Other	6

A graph presenting this information is included as Exhibit 3-1. This analysis is made based upon the classifications made by the Arizona Department of Water Resources; no attempt was made to verify the existing actual uses of these wells. Further, the existing production status of these wells, but an analysis can be made based upon the usage characteristics of water customers metered and served by the City's water system. This analysis is segmented into domestic wells and all other wells:

Exempt wells 69% of the registered wells are classified by the Arizona Department of Water Resources as "exempt"; their production capacity is rated at 35 gallons per minute or less. Exempt well production is assumed to be at a level consistent with single family residential connections within the City's utility system. Based upon discussions with Bureau of Reclamation staff, exempt well production should be increased by 25% to compensate for additional external irrigation usage which typically occurs by these users.

CITY OF KINGMAN
WELL USER TYPES

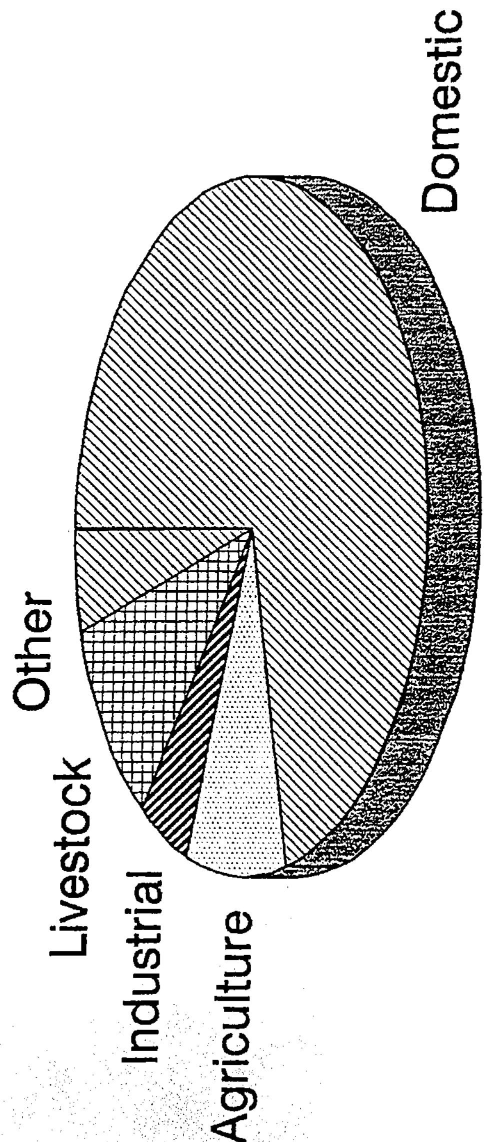


EXHIBIT 3-1

Therefore, total annual usage by these wells is estimated to be 74 acre feet at the present time.

Non exempt wells There are 52 wells which are not City wells and not exempt/domestic wells. Total annual usage by these wells is estimated to be 300 acre feet at the present time.

The usage by these wells is included in the non-City pumping analyzed in Dr. Schmidt's report.

CHAPTER FOUR

WATER RESOURCE ALTERNATIVE DEVELOPMENT

In addition to groundwater, the City has other alternatives to meet its long-term water resources needs:

Direct Usage of Colorado River allocation

Exchange Usage of Colorado River allocation

Effluent Reuse

Effluent Recharge

Stormwater Recharge

DIRECT USAGE OF COLORADO RIVER ALLOCATION

The City has an allocation of 18,500 acre feet annually of Colorado River water. The direct use of the City's Colorado River allocation has been studied on numerous occasions. Two of these studies were used to base projections in this section:

Kingman Project Report by the United States Bureau of Reclamation (April 1971). This report developed alternatives for constructing a water delivery system from the Colorado River east to Kingman.

Kingman/Halite Processing Co. Final Environmental Assessment by the TranAm Energy Group (January 1991). This report developed alternatives for constructing a water delivery system from Lake Mead south to Kingman.

Existing Four Corners Pipeline An additional alternative was also considered. The City was approached by the Four Corners Pipeline Company (which is a subsidiary of Atlantic Richfield) regarding the potential use of their 16" gas line for water delivery purposes.

Treatment Plant Costs

Regardless of the method of transport, Colorado River water will require treatment before it can be used by the City in its potable water system. To fully utilize the 18,500 acre feet allocation, a treatment plant with a capacity of twenty million gallons per day is required. Based upon the costs of similar plants constructed to utilize Central Arizona Project water, as well as Engineering News Record estimates, this facility will require a capital expenditure of $40 million. For comparative purposes, it is assumed that debt will be required for this expenditure, and that a twenty year repayment will be required.

Average annual debt payments would be approximately $3.6 million.

As a practical matter, the City would be unlikely to construct all of the capacity initially. Instead, the plant would probably be constructed in two ten million gallon per day increments. Five million gallons per day would be required immediately, with the remaining five million gallons from the first increment reserved for future growth and peaking. The remaining ten million gallons would be required in ten to fifteen years.

Treatment plant operating, maintenance and replacement costs average around $0.30 per thousand gallons at the present time or approximately $98 per acre foot.

Lake Mohave/Highway/Kingman Pipeline

As presented in Exhibit 4-1, this transportation alternative requires a capital expenditure

Cost Estimate
Kingman Water Adequacy Study
03184-0304-072

Lake Mohave/Highway/Kingman Alignment Current 20-Cities ENR = 5085 (12/92)

Description	Number	Units	Unit Cost	ENR 20-Cities	Adjusted Unit Cost	Extended Cost
36" CML&C Steel Pipe, Ripping (1)	19,000	lf	$125	3800	$170	$3,230,000
36" CML&C Steel Pipe, Blasting (2)	29,000	lf	$145	3800	$190	$5,510,000
36" CML&C Steel Pipe, Trenching (3)	100,000	lf	$141	3800	$190	$19,000,000
Intake Tunnel, 6' Dia. Concr. Lined (4)	50	lf	$720	3600	$1,020	$51,000
Intake Chlorination Facility (5)	1	ls	$115,000	3800	$153,890	$154,000
Intake Pumping Station (6)	1	ls	$565,404	3800	$756,600	$757,000
Pumping Plant No. 2	1	ls	$1,063,368	3800	$1,422,950	$1,423,000
Pumping Plant No. 3	1	ls	$1,007,284	3800	$1,347,910	$1,348,000
Pumping Plant No. 4	1	ls	$1,354,678	3800	$1,812,770	$1,813,000
Pumping Plant No. 5	1	ls	$1,140,848	3800	$1,526,630	$1,527,000
Pumping Plant No. 6	1	ls	$864,179	3800	$1,156,410	$1,156,000
Pumping Plant No. 7	1	ls	$1,537,945	3800	$2,058,010	$2,058,000
Pumping Plant No. 8	1	ls	$1,511,317	3800	$2,022,380	$2,022,000
Pumping Plant No. 9	1	ls	$1,094,880	3800	$1,465,120	$1,465,000
Pumping Plant Surge Tanks	9	ea	$20,222	3800	$27,060	$244,000
Union Pass Tunnel, 6' Dia. Concr. Linec	7,962	lf	$720	3600	$1,020	$8,121,000
Union Pass Regulating Reservoir (7)	234,000	gal	$0.87	3800	$1.20	$281,000
Electrical Transmission Facility (8)	9	mi	$206,000	3600	$290,980	$2,648,000
Rights of Way (9)	35.9	ac	$5,000	4525	$5,620	$202,000
Subtotal:						$53,010,000

NOTES
(1) JMM Overland Construction Unit Cost, 8 ft Trench, Ripping/Excavating
(2) Estimated from JMM Overland Construction Unit Cost, 8 ft Trench, Ripping/Excavating
(3) JMM Road R/W Construction Unit Cost, 8 ft Trench, Pavement Removal/Replacement
(4) KJ/DRD Memo on Jacked, Bored, Tunneled Casings, 9/85
(5) Escalate Well-Head Chlorination System to Design Flow
(6) JMM Water Pumping Station, Medium Complexity, Single Stage Construction
(7) JMM Steel Reservoir Cost Curve
(8) BOR Study Average Unit Cost Escalated
(9) BOR Study Average ROW Cost Escalated

EXHIBIT 4-1

of $53 million. Including the water treatment facility, this would result in the following capital expenditure:

Pipeline	$53,000,000
Treatment Plant	40,000,000
Engineering	9,000,000
Bond Issuance	9,000,000
Total	$111,000,000

Annual debt service on this total project cost would be approximately $9.8 million, or a cost of $530 per acre foot annually for a twenty year period.

Pumping costs for this alternative will be approximately $90 per acre foot annually. As previously discussed, operating costs will be approximately $98 per acre foot. Therefore, the total annual costs of this alternative will be $718 per acre foot.

Lake Mohave/Duvall/Kingman Pipeline

As presented in Exhibit 4-2, this transportation alternative requires a capital expenditure of $61 million. Including the water treatment facility, this would result in the following capital expenditure:

Pipeline	$61,000,000
Treatment Plant	40,000,000
Engineering	10,000,000
Bond Issuance	10,000,000
Total	$121,000,000

Cost Estimate
Kingman Water Adequacy Study
03184-0304-072

Lake Mohave/Duvall Corp/Kingman Alignment Current 20-Cities ENR = 5085 (12/92)

Description	Number	Units	Unit Cost	ENR 20-Cities	Adjusted Unit Cost	Extended Cost
36" CML&C Steel Pipe, Ripping (1)	78,000	lf	$125	3800	$170	$13,260,000
36" CML&C Steel Pipe, Blasting (2)	117,000	lf	$145	3800	$190	$22,230,000
Intake Tunnel, 6' Dia. Concr. Lined (3)	50	lf	$720	3600	$1,020	$51,000
Intake Chlorination Facility (4)	1	ls	$115,000	3800	$153,890	$154,000
Intake Pumping Station (5)	1	ls	$565,404	3800	$756,600	$757,000
Pumping Plant No. 2	1	ls	$1,063,368	3800	$1,422,950	$1,423,000
Pumping Plant No. 3	1	ls	$1,007,284	3800	$1,347,910	$1,348,000
Pumping Plant No. 4	1	ls	$1,354,678	3800	$1,812,770	$1,813,000
Pumping Plant No. 5	1	ls	$1,140,848	3800	$1,526,630	$1,527,000
Pumping Plant No. 6	1	ls	$864,179	3800	$1,156,410	$1,156,000
Pumping Plant No. 7	1	ls	$1,537,945	3800	$2,058,010	$2,058,000
Pumping Plant No. 8	1	ls	$1,511,317	3800	$2,022,380	$2,022,000
Pumping Plant No. 9	1	ls	$1,094,880	3800	$1,465,120	$1,465,000
Pumping Plant Surge Tanks	9	ea	$20,222	3800	$27,060	$244,000
Union Pass Tunnel, 6' Dia. Concr. Linec	7,962	lf	$720	3600	$1,020	$8,121,000
Union Pass Regulating Reservoir (6)	234,000	gal	$0.87	3800	$1.17	$274,000
Sacr. Valley Regulating Reservoir (6)	234,000	gal	$0.87	3800	$1.17	$274,000
Electrical Transmission Facility (8)	9	mi	$206,000	3600	$290,980	$2,648,000
Rights of Way (9)	35.9	ac	$5,000	4525	$5,620	$202,000
Subtotal:						$61,027,000

NOTES
(1) JMM Overland Construction Unit Cost, 8 ft Trench
(2) Estimated for 7 ft Trench, Based on (1)
(3) KJ/DRD Memo on Jacked, Bored, Tunneled Casings, 9/85
(4) Escalate Well-Head Chlorination System to Design Flow
(5) JMM Water Pumping Station, Medium Complexity, Single Stage Construction
(6) JMM Steel Reservoir Cost Curve
(8) BOR Study Average Unit Cost Escalated
(9) BOR Study Average ROW Cost Escalated

EXHIBIT 4-2

Annual debt service on this total project cost would be approximately $11.4 million, or a cost of $616 per acre foot annually for a twenty year period.

Pumping costs for this alternative will be approximately $100 per acre foot annually. As previously discussed, operating costs will be approximately $98 per acre foot. Therefore, the total annual costs of this alternative will be $814 per acre foot.

Lake Meade/Kingman Pipeline

As presented in Exhibit 4-3, this transportation alternative requires a capital expenditure of $84 million. Including the water treatment facility, this would result in the following capital expenditure:

Pipeline	$84,000,000
Treatment Plant	40,000,000
Engineering	12,000,000
Bond Issuance	12,000,000
Total	$148,000,000

Annual debt service on this total project cost would be approximately $13.1 million, or a cost of $708 per acre foot annually for a twenty year period.

Pumping costs for this alternative will be approximately $70 per acre foot annually. As previously discussed, operating costs will be approximately $98 per acre foot. Therefore, the total annual costs of this alternative will be $876 per acre foot.

Existing Pipeline Analysis

The City was approached by a company which owns an existing 16 inch pipeline from

Cost Estimate
Kingman Water Adequacy Study
03184-0304-072

Lake Mead/Red Lake Salt Cavern/Kingman Current 20-Cities ENR = 5085 (12/92)

Description	Number	Units	Unit Cost	ENR 20-Cities	Adjusted Unit Cost	Extended Cost
36" CML&C Steel Pipe, Ripping (1)	228,000	lf	$125	3800	$170	$38,760,000
36" CML&C Steel Pipe, Blasting (2)	98,000	lf	$145	3800	$190	$18,620,000
Intake Tunnel, 6' Dia. Concr. Lined (3	100	lf	$720	3600	$1,020	$102,000
Intake Chlorination Facility (4)	1	ls	$720,000	3800	$963,470	$963,000
Intake Pumping Station (5)	1	ls	$1,319,717	3800	$1,765,990	$1,766,000
Relift Pumping Station No. 1	1	ls	$1,149,893	3800	$1,538,740	$1,539,000
Relift Pumping Station No. 2	1	ls	$1,156,296	3800	$1,547,310	$1,547,000
Relift Pumping Station No. 3	1	ls	$1,246,775	3800	$1,668,380	$1,668,000
Regulating Reservoir (6)	250,000	gal	$0.65	3800	$0.87	$218,000
Electrical Transmission Facility (8)	62	mi	$206,000	3600	$290,980	$18,041,000
Rights of Way (9)	80.8	ac	$5,000	4525	$5,620	$454,000
Subtotal:						$83,678,000

NOTES
(1) JMM Overland Construction Unit Cost, 8 ft Trench
(2) Estimated for 7 ft Trench, Based on (1)
(3) KJ/DRD Memo on Jacked, Bored, Tunneled Casings, 9/85
(4) JMM WWTP Chlorination Cost Curve
(5) JMM Water Pumping Station, Medium Complexity, Single Stage Construction
(6) JMM Steel Reservoir
(8) BOR Study Average Unit Cost Escalated
(9) BOR Study Average ROW Cost Escalated

EXHIBIT 4-3

the Colorado River to the Kingman area. The company proposed transporting water to the City on a per gallon based charge of $0.01. The following additional capital expenditures would be required:

Treatment Plant	$40,000,000
Engineering	4,000,000
Bond Issuance	4,000,000
Total	$48,000,000

Annual debt service on this total project cost would be approximately $4.5 million, or a cost of $243 per acre foot annually for a twenty year period. However, to compare this alternative with other alternatives, the per gallon tariff paid to the pipeline company should be considered. This tariff is approximately $3,260 per acre foot, resulting in total costs of $3,500 per acre foot annually.

Pumping costs for this alternative are included in the tariff. As previously discussed, operating costs will be approximately $98 per acre foot. Therefore, the total annual costs of this alternative will be $3,598 per acre foot.

It should be noted that this alternative has capacity limitations, and that all of the City's allocation cannot be transported through the pipeline. It is estimated that only 3,500 acre feet per year could be received, leaving the remaining 15,000 acre feet unused.

EFFLUENT REUSE

The City of Kingman operates two wastewater treatment plants. The Hilltop Wastewater Plant has a new design capacity of 2 MGD, with an average daily flow of 1.11 MGD and a peak daily flow of 1.50 MGD. The Downtown Wastewater Plant has a design capacity of .52 MGD, with an average daily flow of .35 MGD and a peak daily flow of .42 MGD. Population growth and increased industrial and commercial activity will dictate how much addition sewer capacity is needed and when. An evaluation study was completed by John Carollo Engineers in September of 1991 related to the Hilltop facility. The purpose was to "determine the most feasible plan to expand and upgrade the Hilltop WWTP to continue to provide wastewater treatment to the growing population at a reasonable cost, while meeting State and Federal regulations for environmental protection", including:

National Pollutant Discharge Elimination System (NPDES);

Arizona Water Quality Standards for Surface Waters (numbered as AAC Title 18, Chapter 11, Article 2);

Arizona Water Quality Standards Act (AAC Title 18, Chapter 11, Article 4);

Arizona Regulations for the Reuse of Wastewater (ACC Title 18, Chapter 9, Article 4);

Arizona Groundwater Management Act (Senate Bill 1001, Thirty-Fourth Legislation, Fourth Special Session, 1980);

Arizona Requirements for an Artificial Groundwater Recharge Project and an Underground Storage and Recovery Project (House Bill 2209, Thirty-Seventh Legislature, Second Regular Session, 1986); and,

Arizona Environmental Quality Act (ARS Title 49, Chapter 2, House Bill 2518, Thirty-

Seventh Legislature, Second Regular Session, 1986).

Treated wastewater (effluent) can be utilized to augment existing groundwater and surface water supplies. Municipal direct use options include irrigation of turf facilities, fire suppression, construction compaction and dust control, and industrial cooling. Environmental enhancement could be promoted through wetlands development utilizing effluent as the resource supply.

Hilltop WWTP Evaluation

The aforementioned John Carollo Engineers 1991 report on the Hilltop Wastewater Treatment Plant presented detailed recommendations regarding the treatment and disposal of effluent. Extracts from that report are included in Volume II to this report. The City has the following alternatives for effluent disposal:

irrigation

evaporation

percolation

recharge

underground storage and recovery

To the extent that any of these disposal methods immediately reduce the City's usage of groundwater, they should be given priority consideration. Thus, while the City's new percolation and recharge facility is a viable short-term alternative for effluent disposal, the City may wish to consider other alternatives which involve the reuse of effluent. The above mentioned John Carollo Report concluded that the recommended alternative consist of aerated lagoon secondary treatment followed by wetlands tertiary treatment, with rapid infiltration disposal , sized to the design year (2011) capacity of 3.0 MGD. The City will derive recharge benefits from the percolation of this effluent, given the advanced treatment process being employed. As operational data is generated and analyzed, actual treatment capacity will be established. Based on the capacity, additional recharge potential may be realized. A key element of recharge development is the cost comparison between recharge itself and any direct reuse options.

Effluent Reuse

It is possible to develop an effluent supply from the Hilltop facility and run a reuse line back into the Industrial Park area for industrial cooling, construction and irrigation purposes. If the resort/convention/golf course complex is constructed, then part of that site-specific water budget could be fulfilled with effluent. Using the existing municipal golf course water use as an example, 400 to 600 acre-feet per year would be needed. This reuse option is not cost-effective unless the site-specific demand is sufficient to justify the investment for the requisite infrastructure. The cost-effectiveness determination could change; however, if funding sources, other than water and sewer fees, were made available. These sources could include a water resource development fee or funds derived from an exchange agreement. Depending on the type of activity within the Industrial Park itself, and/or, if the resort/convention center/golf course facility is build in proximity to a contemplated return line, direct reuse is viable prior to the 2011 design year target.

Given the fact that the supply and demand curves do not always match, there would be an effluent storage requirement so as to meet peak demand during the months of June, July, August and September. Increased sewer flows have been quantified during the these months, due to Kingman's summer tourism trade. Effluent use during the fall and winter months can be earmarked for overseeding purposes, if requirements exist. Based on the various development scenarios in the General Plan, the conclusion reached is that there will be some direct use opportunities for effluent beginning around the 2011 timeframe. Opportunities could be limited; however, due to the expense incurred of developing the resource and the distance between treatment facilities and potential end-users.

The City, as a matter of development strategy, wants to avoid a proliferation of package wastewater plants. The preferred approach is to match plant expansion with those end-users who can utilize the effluent in order to displace groundwater.

If the City were to actively pursue effluent reuse, the following criteria should be noted:

- orchard crops can be irrigated if the treated effluent is not directly applied to the fruit. Use of treated effluent directly on crops intended for human consumption is prohibited.
- non-edible crops (such as alfalfa) can be irrigated with treated effluent. Also, pastures can be irrigated if standing ponds do not result.
- landscaped areas (such as cemeteries, medians and golf courses) can be irrigated if properly posted. Spray irrigation should occur at times when facilities are not in use.

- parks, school grounds, athletic fields and playgrounds can be irrigated, with similar posting restrictions applied.

RECHARGE OF EFFLUENT

In addition to the recommendation in the John Carollo Study which provides for sewer capacity and disposal through 2011 and the direct use options that begin to occur during that same timeframe, the City can also pursue a program to recharge its effluent for future use and/or aquifer rehabilitation.

The State passed enabling legislation in 1986 that allows for the recharge of treated wastewater. Quality standards are established in order to protect the groundwater aquifer from contamination, in that the goal is to have the water suitably treated and be further enhanced in quality from the natural processes of the recharge itself. The water quality concern is paramount. There have been several successful effluent recharge projects carried out throughout the state. As previously indicated, with the Hilltop facility utilizing new rapid infiltration basins, recharge is already occurring.

Costs of Effluent Reuse

The costs of effluent reuse were identified by John Carollo Engineers, and are presented in Exhibit 4-4. These costs are for a 3.0 MGD treatment and reuse system, or approximately 3,300 acre feet annually. The annual debt service on these costs are $1.2 million. Thus, the capital cost per acre foot is $364 per acre foot for effluent reuse.

STORM WATER RUN-OFF AND FLOOD WATER CAPTURE

Due to the extremely poor quality of the storm water run-off and flood water, a determination was made that the cost of storage and treatment is too high for any viable program to be developed which would utilize this water directly. In addition, given the average annual rainfall of eleven inches, per year, the resource itself would be limited, at best.

There is a limited possibility for detention and percolation of run-off for recharge purposes. Low-cost impoundment of storm water can be constructed. It should be tied directly into generation of flood control benefits so as to maximize the return on dollars spent. If monies became available, this limited option for recharge could be pursued.

EXISTING GROUNDWATER DEVELOPMENT

A continuing source of groundwater should be maintained from the wells located in the downtown area. The depth to groundwater has changed very little from the time these wells were first drilled to supply steam engines owned and operated by the Santa Fe Railroad. The quality of this water is very good, and the cost of pumping is relatively inexpensive. Rechargeability may be better due to the spring-fed nature of the sub-basin. New wells can be drilled in the downtown area in order to service related growth.

It is extremely important that the hydrogeologic studies used in estimating both the short-term and long-term availability of groundwater supplies in the Hualapai and Sacramento Basins be validated with intensive field work, including test drilling for production potential and quality affirmation. Kingman must have site-specific plans for additional groundwater development in its capital improvement project program. Coordination between city staff and the hydrogeologic consultants is essential.

In addition, the City must ensure that privately-owned wells are inventoried when either drilling or abandonment occurs. The reason being is that the City has a vested interest in making sure that non-municipal groundwater pumping is monitored to determine whether adverse impacts may be occurring. In the case of a private well being abandoned, subsequent use of that well for dumping or other unlawful disposal could jeopardize water quality. Proper capping of an abandoned well is also necessary for safety reasons. Under the laws of the State of Arizona, there are formalized well drilling and registration requirements, as well as abandonment provisions. It is recommended that Kingman consider adoption of local ordinances which supplement state law, so as to protect the public.

CHAPTER FIVE

WATER CONSERVATION PLAN

Whereas supply management is the first half of the water resources equation, demand management is the second half. Conservation of our natural resources is receiving high profile national attention. The City has already developed an environmental sensitivity, as reflected in stated goals and policies, and should be commended for this attitude. Kingman will have a great influence over water demand by virtue of its land use planning and level of aggressiveness in the types of programmatic reductions through conservation that can be cost-effectively implemented.

The City has been notified that both the Bureau of Reclamation and the Arizona Department of Water Resources will require that a comprehensive conservation program be developed and adopted. Future allocation related decision-making and water adequacy determinations will depend, in part, on the quantification of water savings that can be generated from conservation efforts. In addition, Kingman officials want a stand-alone document that can be used to amend the building code regulations now in place.

Under the Bureau's proposed regulations for administering entitlements to Colorado River Water, Section 415.19, it is stated that "given the arid environment in the Lower Basin and the increasing demands for water within the three states (alluding once again to Arizona, California, and Nevada), it is critical for all entitlement holders to employ reasonable conservation practices." Existing regulations, such as Title 43 Code of Federal Regulations (CFR) part 417, entitled "Procedural Methods for Implementing Colorado River Water Conservation Measures with Lower Basin Contractors and Others," authorizes the Regional Director, under 43 CFR 417.2, to: "conduct such consultations with each Contractor as the Regional Director may deem appropriate as to the making by the Regional Director of annual recommendations relating to water conservation measures and operating practices in the diversion, delivery, distribution and use of Colorado River water, and to the making by the Regional Director of annual determinations of each Contractor's estimated water requirements for the ensuing calendar year to the end that deliveries of Colorado River water to each contractor will not exceed those reasonably required for beneficial use." In addition, long-term water conservation plans shall be required of all entitlement holders. Each plan shall address best management practices and shall contain reasonable and economically feasible goals, measures, time schedules, and other such information as may be required by regulation or law, and subject to review and approval. The express goals of the federal program is to foster improvements in the efficiency of use and management of water supplies provided by Reclamation and non-federal projects in order to:

a. provide a source of water to meet growing water needs for economic growth and human consumption;

b. improve instream flows for fisheries, wildlife, riparian habitat, and recreation;

c. improve and protect surface and ground water quality conditions through the reduction of non-point and point sources of pollution;

d. improve the economics of water supply and use; and e. conserve energy.

State-required water conservation plans or guidelines can be used to satisfy federal requirements. Conservation plans should be updated and evaluated for efficacy.

<u>PLUMBING CODE REVISIONS</u>

On July 13, 1992, Governor Symington signed into law a bill to ensure that only water efficient plumbing fixtures are sold, distributed and installed in Arizona. Effective January 1, 1994, statewide standards will limit the amount of water used in toilets, urinals, showerheads, faucets, evaporative coolers and decorative fountains. Waivers may be issues when devices:

a. are not available

b. will be used in historic buildings

c. will cause a health or safety hazard

d. where there are other hardships.

Any non-conforming fixtures in stock as of the effective date may be sold and installed.

The enforcement process for this legislation recognizes the primary responsibility of local building inspectors to enforce building codes. The Arizona Department of Water Resources' role in enforcement varies depending on whether the city or county chooses to enforce within its boundaries. If the city or county chooses not to enforce the provisions, the state would. Enforcement would be directed against the manufacturer or company that brought the plumbing fixtures/devices into the state and not against the local retailer or installer. Enforcement against homeowners that install their own fixtures is specifically prohibited. Water savings will initially be small, and then grow as new units come on line.

Willdan conducted a limited survey of the Kingman planning area to determine to what extent area wholesalers and retailers already offer low-flow plumbing fixtures/devices and to ascertain the levels of water conservation labeling. The results are contained in Exhibit 5-1.

There, most likely, will be efforts to repeal this new legislation based on concerns about governmental intrusion into homes and businesses, higher costs and performance reliability. A number of local jurisdictions, such as Phoenix, Glendale, Tucson, Scottsdale and Nogales, have already adopted low-flow plumbing fixture ordinances. All performance and sanitary standards are being met. Improvements in fixture technology and increasing market penetration have resulted in even better performance and lowered costs. Other states have also adopted similar legislation to Arizona (see Exhibit 5-2).

Notwithstanding the status of the state legislation, it is recommended that Kingman adopt the standards that are established in the current law through passage of requisite municipal ordinances prior to January 1, 1994. In addition, the City should work with Mohave County to seek passage of parallel county ordinances. Passage of a local ordinance will better serve the City in controlling water use and being better able to address the site-specific problems through a variance procedure that becomes necessary when low-flow fixtures are not readily available. Real world situations that may arise include:

a. low-flow handicapped fixtures are not widely marketed yet;

b. schools and other large public facilities with a need for vandal-proof fixtures may not be able to be retrofitted;

c. production stoppages or shortages due to strikes, business climate changes, natural disaster, etc. could occur; and

d. other enumerated instances experienced by builders and developers.

CITY OF KINGMAN
LOW-FLOW FIXTURES/DEVICES SURVEY

OUTLETS	COMMODES	SHOWER HEADS	BATHROOM FAUCETS	KITCHEN FAUCETS	LABELING QUALITY
WHOLESALER #1	AVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE	MODERATE
WHOLESALER #2	UNAVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE	MODERATE
RETAILIER #1	UNAVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE	EXCELLENT
RETAILIER #2	UNAVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE	EXCELLENT
RETAILIER #3	UNAVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE	EXCELLENT
RETAILIER #4	UNAVAILABLE	AVAILABLE	AVAILABLE	UNAVAILABLE	MODERATE
RETAILIER #5	UNAVAILABLE	AVAILABLE	UNAVAILABLE	UNAVAILABLE	MODERATE

EXHIBIT 5-1

STATES THAT HAVE ADOPTED LOW FLOW PLUMBING FIXTURE REGULATIONS

(In Gallons per flush for toilets and per minute for rest as of 05/05/92)

STATE	EFFECTIVE DATE	WATER CLOSETS	URINALS	SHOWERHEADS	LAVATORY FAUCETS	KITCHEN FAUCETS
Arizona (H.B. 2440)	01/01/94	1.6	1.0	3.0 @ 80 psi	3.0 @ 80 psi	3.0 @ 80 psi
California	01/01/92	1.6	1.0	2.5 @ 80 psi	2.2 @ 60 psi	2.2 @ 60 psi
Colorado	01/01/90	3.5		3.0 @ 80 psi	2.5 @ 80 psi	2.5 @ 80 psi
Connecticut	10/01/90 01/01/92	1.6	1.0	2.5	2.5	2.5
Delaware	07/01/91	1.6	1.5	3.0 @ 80 psi	3.0 @ 80 psi	3.0 @ 80 psi
Georgia - Res. - Comm.	04/01/92 07/01/92	1.6 1.6	1.0 1.0	2.5 @ 60 psi 2.5 @ 60 psi	2.0 2.0	2.5 2.5
Maryland	01/31/92	1.6	1.0	--	--	--
Massachusetts	03/02/89 01/01/88 09/01/91	1.6 (2-piece) 1.6 (all others)	1.5	3.0		
Nevada	03/01/93	1.6	1.0	2.5	2.5	2.5
New Jersey	07/01/91	1.6	1.5	3.0	3.0	3.0
New York	1980 01/26/88 01/01/91 01/01/92	1.6	1.0	3.0 @ 60 psi	2.0	3.0
North Caroline	01/01/93	1.6	1.5	3.0	3.0	3.0
Oregon	07/01/93	1.6	1.0	2.5	2.5	2.5
Rhode Island	09/01/90 03/01/91	1.6 (2-piece) 1.6 (all others)	1.0	2.5 @ 80 psi	2.0 @ 80 psi	2.0 @ 80 psi
Texas	01/01/92	1.6	1.0	2.75 @ 80 psi	2.2 @ 60 psi	2.2 @ 60 psi
Utah	08/15/91	1.6	--	2.5	--	--
Washington	07/01/93	1.6	1.0	2.5 @ 80 psi	2.5 @ 80 psi	2.5 @ 80 psi

EXHIBIT 5-2

An example of the type of ordinance that should be considered is from the City of Glendale, Arizona, and is included in Volume II of this report.

A new ordinance would amend Article VI, Sections 5-86, et. seq., of the existing City Code, in which Uniform Plumbing Code provisions that govern construction are now the standard. Section 5-158 is the only other water-wasting specific provision which addresses the escape of water, it reads: "It shall be unlawful for any person to willfully or negligently permit or cause the escape or flow of water from the Municipal Water System in such quantity as to cause flooding, to impede vehicular or pedestrian traffic, to create a hazardous condition to such traffic, to create a condition which constitutes a threat to the public health and safety, or to cause damage to the public streets or alleys of the City of Kingman. Each violation of this Section, and each day on which a violation occurs, shall be considered a separate offense."

Section 5-158 should be retained and, obviously, enforced.

METER REPLACEMENT

A reoccurring problem for any service area is that water meters, due to normal wear and tear, develop inaccuracies as to usage. Industry-wide experience shows that, over time, meters tend to run slower, thus reflecting lower water consumption than is actually the case. This trend not only results in lower water use reporting, but it also has an adverse impact on revenues, since customers are not being billed properly for actual amounts used. As of the last quarter of 1992, the City has already embarked upon and completed a meter repair and replacement program for approximately seventy percent (70%) of its service area accounts (see Exhibit 5-3). This aggressive approach should be continued.

CITY OF KINGMAN
NUMBER OF ROCKWELL SENSUS METERS IN SERVICE
AS OF SEPTEMBER 1992

METER SIZE	NUMBER INSTALLED
3/4"	7867
1"	108
1 1/2"	56
2"	78
3"	16
4"	10
6"	1
TOTAL	8136

EXHIBIT 5-3

PLUMBING RETROFIT PROGRAM

Depending on the level of funding made available, the City has two options for a retrofit program. One option, is development of a low-cost program that would provide a package of low-flow shower heads or flow restrictors and toilet dams. Installation would be done by either city staff, private contractors or the individual homeowner/business person. A contracted for bulk purchase of the fixtures could be negotiated with the intent to obtain the lowest per unit cost and best possible performance warranty. Costs for installation would vary depending on who did the work. It is recommended that only those fixtures installed prior to adoption by the City of the existing Uniform Plumbing Code be retrofitted, since these are the highest water using devices and this is where the greatest potential for savings can be realized. Through water billing information, a determination can be made to quantify the number of units to be targeted for retro-fit. Based on previous experience in other Arizona cities, expectations are that the market penetration for the retro-fit program is approximately ten percent (10%). This would be the goal in the first year of implementation. The unit price, per retro-fit package, should be less than twenty-five dollars ($25.00), subject to negotiations with the supplier.

The second option is a higher cost alternative which would entail a more comprehensive retrofit program whereby the entire water using fixture itself would be changed-out, instead of simply being modified as in the first option. For example, the pre-Uniformed code fixture would be retrofitted with a fixture which meets the new state plumbing code requirements. The cost of the new fixture, or a rebate to the end-user, would be paid for by the City. This type of program is expensive, if the level of participation is high. There have also been concerns raised with regard to liability issues if City staff entered premises to do retro-fit work.

TURF AND WATER AMENITY LIMITATIONS

Based on a number of studies conducted in response to requirements of the Arizona Groundwater Management Act, the general conclusion has been reached that exterior water use for landscaping is greater than interior water usage, except when large amounts of water are used for industrial processing or cooling. In an effort to reduce landscape watering, several municipalities have adopted turf limitation ordinances as part of their conservation programs.

Large turf facilities and water amenities, such as fountains should be discouraged. This would obviously not apply to revenue generating commercial facilities such as golf courses.

The Cities of Scottsdale and Phoenix provide excellent examples of the type of programs that can be implemented. Key features of their turf limitation efforts include: placement of specific size and water use restrictions, requiring effluent use wherever possible, separate metering and stiff surcharges if water use limits are exceeded. For example a city would limit the amount of turf and high water use plants in new developments to no more than fifty percent (50%) of the landscapable area or ten percent (10%) of the net site size, whichever is less. Individual residential lot turf restrictions can also be based on either a square foot or percentage of lot size methodology.

EXTERIOR WATER SAVINGS PROGRAMS

Exterior water use can be reduced by providing the necessary incentives or directives to employ newer technology. Moisture sensors, sprinkler timers, drip and sub-surface irrigation systems, automatic leak detection and shut-off devices, are all available for both homes and businesses. Based on the per unit cost of these types of items, the City may want to provide citizens with an incentive to purchase and install the latest in conservation technology, if costs are high. The City of Glendale has experienced success with its rebate program (see Volume II). If per unit costs are lower than or comparable to items previously employed for outdoor use, then a rebate is not necessary.

Consideration should also be given to adoption of a landscape conversion program which would afford a homeowner or business owner the opportunity to convert from an existing high water using landscape to a lower water using alternative. Given the expense involved with landscape conversion, a rebate incentive is recommended. Again, the City of Glendale has an excellent program to reference.

NEW RATE STRUCTURE

It is always difficult for a municipal provider to increase utility rates for any service (water, sewer, sanitation, etc.) due to the political response from ratepayers. Well-run utilities can show that overhead and administrative costs are being kept to acceptable levels. Nonetheless, rate increases are inevitable as the cost of delivering the service to the customer increases. It is important that customers are educated as to the ever-increasing costs of delivering water service. Infrastructure must be constructed, operated and maintained. New federal and state environmental mandates have been adopted and must now be met. Of immediate concern will be requirements promulgated as part of the reauthorizations of the Clean Water Act, the Safe Drinking Water Act and the Endangered Species Act. As inflation occurs, the water purveyor, as a "consumer", itself must pay higher costs for material, labor and utilities. Financing costs rise as interest rates increase. Reserve or contingency funds are necessary so that emergencies or unexpected events can be responded to. All of these factors influence what the customers pay for water delivery service. There needs to be full-cost recovery, otherwise the utility operates with a deficit or must be financially underwritten or subsidized by money from the general fund or tax revenue.

The rate structure must be balanced in such a way to ensure full cost recovery, to promote conservation, and to allow for quality, future growth to occur. The cost burden of expansion will be shared by growth, as it occurs; as well as, current ratepayers who continue to use the existing resources base. The key is how the system users respond to financial inducements/incentives.

Water systems typically establish one of the following water rate structures:

Flat Rate - all customers are charged the same amount regardless of the actual volume of water used.

Declining Block Rate - customers are charged progressively lesser amounts per billing unit of water as an increased volume of water is used.

Uniform Rate - the price of each billing unit of water is the same regardless of the level of consumption.

Inverted Block Rate - An increasing price is applied to each succeeding block of usage or billing unit of water above some predetermined level or levels (this is the predominant structure used by many Arizona municipal water purveyors for single family residential customers).

Excessive Average Rate - similar to the inverted block rate, but individualized for each customer. The customer is charged a surcharge when usage exceeds a historical average.

Combination Rate - allows for several different structures to be used for each customer category.

The inverted block rate and the excessive average rate are generally recognized as the most effective means for encouraging water conservation. Kingman's water billing is based on an inverted block rate system (see Exhibit 5-4). Since the City already has a solid billing system in place that promotes conservation, consideration should be given to excessive average rate surcharges on accounts that have abnormally high water use not attributed to specific one-time events or explainable circumstances such as the filling of a swimming pool, overseeding or establishing roots for new landscaping, etc.

WATER THEFT/LEAK DETECTION

After the City has evaluated its water production, billed water and unbilled water use figures, the difference, if any, reflects an unaccounted for total. Industry standards dictates that this "loss" should be no more than ten percent (10%). This can be attributed mainly to system leakage, since water mains rarely remain absolutely leak proof over time. There may also be situations where water theft is occurring. In checking the City's records for the past five years, the unaccounted for percentage has averaged less than eight percent. This is a solid track record. Nevertheless, there may isolated, site-specific losses that the City has identified as a possible problem. If this is the case, scrutiny of the water delivery system in the identified area should be conducted to determine if line loss exceeds the norm. A water audit, conducted by a specialist in system evaluation, should be considered. A key consideration is the knowledge that lost revenue from water loss can be recovered by taking corrective action. Finding additional revenue pays for the costs associated with finding leaks.

A water theft ordinance is already in place which helps deter theft. The City needs to stay aggressive in enforcing the ordinance. Although responsibility for monitoring water use rests mainly with the Public Works and Customer Service Departments, it would benefit the City to coordinate efforts with other municipal employees on how to identify potential water theft problems. The public safety personnel, in particular, can really help in "keeping their eyes and ears open" when patrolling the service area.

COMPREHENSIVE PUBLIC EDUCATION PROGRAM

PUBLIC AWARENESS

Public awareness of the need for water conservation is a critical element of water resource management. In order to provide the necessary example, governmental entities should first start with a water audit of their own facilities to determine where both interior and exterior savings can be generated. Citizens are much more receptive to conservation ideology when they can see demonstrative and substantive attempts being made by the City itself. For example, the City should: use proper irrigation practices at its turf facilities and in its landscape watering; use recycled water whenever possible; aggressively and uniformly enforce water wasting ordinances; provide necessary customer assistance in answering water resource questions and highlight citizen and business efforts that result in better resource management.

WATER BILL INSERTS

The City, as part of its water/sewer bill mailings, can use inserts for conveying water conservation and water resource information to the customers. The inserts alone will not be useful unless a corresponding marketing effort to get customers to read the inserts is made part of the program. Incentives, such as discount coupons or contests, are suggested.

In conjunction with the water bill inserts, the City may want to consider adoption of a "goal billing" program, which has been extremely successful in Scottsdale, Arizona. Goal billing provides each customer, as part of the monthly billing statement, with a water use target based on good conservation being practiced. Incentives can be developed for users who meet the "goal", and disincentives or penalties for users who do not meet the "goal". By having the figures on the billing statement, the customer can actually map the progress he or she is making in reducing water use. If abrupt increases are noticed, this can also serve as a warning sign that leaks may exist, waste is occurring, meters are malfunctioning, or some other factor is present that requires investigation of correction.

DISPLAYS AND EXHIBITS

Materials on water conservation and the importance of sound resource management should be made available to the citizens at little or no cost. This material can be distributed at government offices, libraries and schools, as deemed appropriate.

Kingman should also consider approaching the school districts to ascertain if water conservation and natural resource management, along with other environmental subject-matter, can be incorporated into existing curriculum, or be made part of newly developing curriculum.

MEDIA ANNOUNCEMENTS AND FEATURED STORIES

Arizona is one of the few states where water issues make front-page news with some degree of regularity. The media plays a very important role in educating the public and in bringing issues to the fore-front. The City needs to work with the local media in getting conservation information out to readers and listeners.

A weekly or monthly "water watch" message in either print or electronic media format should be developed. Input from various sources, including: elected officials, citizens, special guests or experts in the field, can be solicited. Participation in building a conservation ethic in the community must be encouraged. The media is always a good place to start.

SPEAKERS BUREAU

The city can coordinate with other municipalities in developing a speakers bureau, which features water resource experts. The Arizona League of Cities and Towns, the Western Arizona Council of Governments, the Arizona City Management Association, the Arizona Chapter of the American Public Works Association, the Arizona Planning Association, the various State Universities, and the law firms dealing with water resource issues can all be called upon to provide the names of potential speakers. Public acceptance of conservation efforts will depend greatly upon the ability to show that specific programs are achievable, cost-effective and actually do result in measurable savings that benefit the service area. One of the ironic results of aggressive conservation is that with reductions in water use, there is also a corresponding reduction in water revenues due to the fact that less water is being sold. Keeping this in mind, utility and budget personnel must carefully chart conservation impacts in terms of both the resource use and revenue streams.

A comprehensive listing of the various water conservation programs that have been implemented by the member cities that comprise the Arizona Municipal Water Users Association has been provided in Volume II. The menu of activities include:

ORDINANCES AND OTHER REGULATORY APPROACHES

MESA

Lakes and turf ordinances

Landscape ordinance

Low-flow plumbing fixtures ordinance

Water theft ordinance

TEMPE

Landscape ordinance

Water Conservation ordinance

Low-flow Fixtures and devices ordinance

Water wasting ordinance

CHANDLER

Landscape ordinance

Low-flow fixture and devices ordinance

PHOENIX

Landscape ordinance

Plumbing products law enforcement

Low-flow fixture and devices ordinance

Water wasting ordinance

Water theft ordinance

Landscape policy

PEORIA

Proposed Landscape ordinance

Low-flow fixtures and devices ordinance

Water wasting ordinance

SCOTTSDALE

Model home ordinance

Low-flow fixtures and devices ordinance

Water wasting ordinance

Landscape ordinance

Goal billing and surcharge program

GLENDALE

Low-flow fixtures and devices ordinance

Water wasting ordinance

Water theft ordinance

GOODYEAR

Low-flow fixtures and devices ordinance

Landscape policy

GILBERT

Low-flow fixtures and devices ordinance

Water theft ordinance

Landscape policy

INCENTIVE PROGRAMS

MESA

Low water use landscape rebate program

TEMPE

Rebate program

GLENDALE

Landscape rebate program

Low-flow fixtures and devices rebate program

GOODYEAR

Low-flow toilet rebate program

SCOTTSDALE

Low-flow plumbing fixtures rebate program

Landscape rebate program

WATER AUDIT PROGRAMS

CHANDLER

Water consumption notification program

Turf facility audit program

Industrial/commercial audit program

PEORIA

Water consumption notification program

Multi-family apartment complex water audit program

MESA

Turf audit program

Commercial/industrial program

Home water audit brochures

PHOENIX

Irrigation audit program

Industrial/business/government site visit program

Customer self-audit program

GLENDALE

Multi-family apartment complex water audit program

ET PROGRAM (Weather data gathering activities) these types of programs are designed to map weather changes with water consumption patterns, so as to enhance resource planning. Phoenix, Scottsdale, and Tempe all have ET programs.

LOW-FLOW PLUMBING RETROFIT PROGRAMS

MESA

Water conservation kit distribution

CHANDLER

Water conservation kit distribution

Dye tab distribution (for leak detection)

GOODYEAR

Water conservation kit distribution

TEMPE

Water conservation kit distribution

SCOTTSDALE

Dye tab distribution (for leak detection)

PHOENIX

Dye tab distribution (for leak detection)

Plumbing hardware retrofit

GLENDALE

Flow restrictor distribution program

PEORIA

Retrofit pilot program

RESEARCH AND DATA COLLECTION

MESA

MIS for turf facilities

SCOTTSDALE

Water use data base development (tied to goal billing)

Irrigation technologies studies

GLENDALE

Irrigation technologies studies

Plumbing fixtures studies

Liquid Organic Soil Conditioner Pilot Programs

Low consumption toilet retrofit data collection program (for multi-unit facility)

PHOENIX

Irrigation technologies studies

Best available technologies studies

Plumbing retrofit research

TECHNICAL ASSISTANCE

PHOENIX

Technical assistance for turf facilities

MESA

Technical assistance for commercial/industrial water users

Given the work-product and oversight responsibilities of water conservation programs, it is recommended that the City consider hiring a full-time water conservation coordinator/water resource planner for implementation purposes. In addition to the programmatic involvement, the employment description should also include a legislative and water resource planning function. Placement of the employee can be within the City Manager's Office, the Public Works Department, or even in the Planning Department.

CHAPTER SIX

EVALUATION OF EXTERNAL FACTORS

BRIEF HISTORY OF WATER ON THE COLORADO RIVER

The Colorado River Compact of 1922 apportioned Colorado River water for beneficial and consumptive use between the upper and lower basin states. Subsequent laws and court decisions resulted in further dividing the water by assigning basic apportionments of 7.5 million acre-feet (an acre-foot of water equals 325,851 gallons or the equivalent to service a family of five for one year) to the upper basin and 7.5 million acre-feet to the lower basin (which is comprised of the states of Arizona, California and Nevada). Individual lower basin state assignments of 4.4 million acre-feet to California, 2.8 million acre-feet to Arizona and 300,000 acre-feet to Nevada resulted from Congressional passage of the Boulder Canyon Project Act in 1928. In addition to the 15 million acre-feet compact designation, the United States also has a treaty obligation to provide 1.5 million acre-feet annually to Mexico. River losses from seepage and evaporation are estimated to account for an additional 1.5 million acre-feet. Until now, the Colorado River has been a reliable water supply. Of the lower basin states, only California has used its full entitlement. Under a 1964 Supreme Court decree in California v. Arizona, unused allocations can be temporarily used by other allotees; and California has taken advantage of this provision. However, with increasing water demand now being attributed to municipal and industrial growth along the river, in Central Arizona, in Southern Nevada and in Southern California, a new era of limits is dawning. In 1993, the Central Arizona Project will be making deliveries to regulatory storage space behind the newly constructed New Waddell Dam, and this will increase Arizona demand. The uncertainty now lies in whether Central Arizona Project agricultural sub-contractors will take delivery of any sizable amounts of water, given the financial hardships faced related to repayment of distribution loan and private bond debt, coupled with high water costs when compared to commodity price returns.

Contracts for use of Colorado River water are required under federal law, and the Secretary of Interior is given the authority to allocate this resource. The Secretary traditionally seeks guidance from the state in regard to allocation within the state. Arizona, through the Department of Water Resources, works closely with individual contracting entities in making specific service area need recommendations. Lower basin water service contracts must be studied in order to understand the unique terms and conditions. This study will contribute to contract development and formulation.

BOULDER CANYON PROJECT ACT AUTHORIZATION

The Act, which was a legislative response to water management concerns, also divided the lower basin entitlements in which Arizona received its 2.8 million acre-feet allocation. Other provisions included:

- authorizing construction of the Hoover Dam, the Imperial Dam and the All American Canal;
- "irrevocably and unconditionally" limiting California to an annual consumptive use of 4.4 million acre-feet annually;
- requiring all users of water from the project to have executed contracts with the

Secretary of Interior; and,

- disposing of hydropower via contracts.

A lawsuit was filed in 1952 as a result of California's efforts to dispute Arizona's allocation when the State attempted to seek federal enabling legislation for construction of the Central Arizona Project.

The United States Supreme Court ruled on the matter, and in 1964 issued its decree in the case of California v. Arizona which resolved key issues, including:

- confirmation of the lower basin entitlements established in the Boulder Canyon Project Act;
- determined federal reserved water rights existed in the lower basin;
- affirmed the Secretary's contracting and allocation authority; and,
- acknowledged the roles of states and state law.

Supplemental decrees were issued in January, 1979, which dealt primarily with giving priority to present perfected rights over contract entitlements; and April 1984, which made adjustments to Native American water rights along the Colorado River.

COLORADO RIVER CONTRACTS

Under provisions of the aforementioned federal law and judicial decrees, a contract was offered by the Secretary of the Interior to the City of Kingman for an amount not to exceed 18,500 acre-feet annually. The contract (Department of Interior, Bureau of Reclamation

Contract #14-06-W-202), was dated November 14, 1968. The said amount was based on the recommendation received from the Arizona Interstate Stream Commission, which was the predecessor of the Arizona Department of Water Resources. This contract actually has several components to it. A "total project diversion" would be 23,300 acre-feet, with enumerated entitlements of 3,700 acre-feet for Duval Corporation's extensive mining and milling operations around Ithaca Peak, 1,100 acre-feet for the National Park Service's Katherine Landing recreational development, and 18,530 plus acre-feet for the Kingman City service area.

It was contemplated at the time that the delivery of contracted for Colorado River water would be directly diverted from Lake Mohave, or any other suitable diversion or delivery point, and then be put to beneficial use within the designated service area.

Contract provisions in Article 19 require the City to "order, divert, transport and supply water to use ... within 25 years". This, coupled with Reclamation Law review requirements, have resulted in a November 1993 deadline for the City to formally execute its contract.

The Arizona Department of Water Resources (ADWR) plays a key role in this decision-making process for several reasons. The Bureau of Reclamation, as contracting agent for the Department of the Interior, will relay extensively on the Department's input as to Kingman's Colorado River allocation. ADWR is not simply looking for a stand-alone justification for the City to use its Colorado River entitlement; but rather, the Department will be evaluating the future water resources outlook for the entire service area in order to determine water adequacy. Even though Kingman is not within an Active Management Area, as defined in the State's Groundwater Code, and therefore not subject to 100-year assured water supply requirements, there is still water adequacy criteria which must be met, in order for growth to occur. The potential for serious groundwater overdraft and groundwater quality degradation will be closely scrutinized.

ENVIRONMENTAL FACTORS

CLEAN WATER ACT REAUTHORIZATION

Congress continues to deliberate on the reauthorization of the Clean Water Act (CWA) this legislative session. Due to election year politics and controversy over wetlands protection, little progress was made in 1992. CWA amendments will mean increased federal and non-federal costs. According to a recent Environmental Protection Agency (EPA) report "Environmental Investments: The Cost of a Clean Environment" (December 1990), total annual water pollution control costs have increased steadily - from $10 billion in 1972 to $37.5 billion in 1987.

By the year 2000, this figure is expected to reach approximately $64 billion, annually. This figure includes quality costs of the CWA, Marine Protection, Sanctuaries and Research Act, as well as, drinking water treatment. Point source control costs have accounted for more than 90% of the expenditures thus far, primarily due to local spending for sewer services and wastewater treatment and to private expenditures for the control of industrial wastewater effluent and pretreatment of wastewater discharges to publicly owned treatment facilities.

Finding the fiscal resources and allocating CWA related costs among the federal government, state and local municipalities and the private sector should be of major concern to water purveyors, businesses and domestic customers. During economic slowdowns or times of personal "belt-tightening", are American families able to afford new cost overhead due to point and non-point source control measures? Are limited fiscal resources being wisely allocated in a cost effective manner?

The major issues of interest during the CWA debate will include municipal wastewater treatment, combined sewer overflows and non-point source protection. Other issues are wetlands, market based incentives and permit fees.

A program of grants for State Water Pollution Control Revolving Funds, or loan programs, was initiated under the CWA amendments in 1987. This program was designed to give states greater flexibility in exchange for a phaseout of federal assistance for wastewater treatment construction after Fiscal Year 1994. States, including Arizona, particularly those with smaller communities with limited ratepayer and/or taxpayer bases, have had difficulties implementing this new program. With current financial needs for wastewater treatment construction over $80 billion nationwide, funding will be a priority during the CWA reauthorization process. The Congressional General Accounting Office has predicted that within the next 10 years, state revolving funds will meet only one-third of demand. Smaller communities lacking an industrial base face the real dilemma of paying for huge capital debt for clean water without the financial and management resources and economies of scale to meet water quality needs.

Nonpoint source pollution, including pollutant runoff from city streets, farms, forests, mines and other areas, has been estimated by the EPA to be responsible for up to sixty percent (60%) of current water quality standards violations. All states were required to develop programs to manage nonpoint source pollution under the 1987 CWA amendments. However, federal appropriations have fallen short of authorized funding levels due to deficit constraints.

Congress will continue to address the "total ecological health" of our nation's water, including both sensitive habitats and critical areas such as wetlands. Municipalities, farmers, land developers, industry and other groups want to minimize costs.

In response to this concern, EPA has been examining options for using market-based approaches to solving water quality problems. Economic incentives would be used to spur local interests, businesses and private landowners to solve their own problems. This would be in contrast to the classic technology driven, command and control strategies. For example, trading between point and nonpoint sources could be allowed to control such nutrients as nitrogen and phosphorus. Moreover, mandated controls on nonpoint sources as a prerequisite for a successful trading program could lead to "performance standards" for the agricultural community, if localized opportunity presents itself.

Fees are under consideration to increase revenue sources to fund water quality management activities. The new CWA amendments could require states to collect National Pollution Discharge Elimination System (NPDES) permit fees from industrial and municipal sources to cover a majority of the state's water quality program. As a market-based incentive, industrial dischargers could also be required to pay fees based on the volume and toxicity of the discharge.

It is important to note that the 1986 Tax Reform Act capped the amount of tax exempt bonds for certain activities (see Chapter Seven of this report) which could be issued on a state-by-state basis by state and local government agencies, including bonds used for environmental project funding. For instance, the cap would apply to a municipality where the major user is a private entity. In addition, where pretreatment of industrial waste may be most cost effective, the 1986 Act makes it difficult to issue tax exempt debt.

There is increasing interest in privately financed and operated wastewater treatment facilities. In a western water project nearing completion, one company has shifted the initial capital risk of project planning and permitting to the private sector through a unique "public-private" partnership. The project itself belongs to the sponsoring public agency and is paid for through the application of user fees. One of the major benefits of this partnership to the public agency is that the use of general tax revenues is eliminated or at least minimized.

The federal budget deficit, continued federal expenditure reductions, and scarce local capital resources have made the resolution of financing problems the major task during CWA reauthorization. Those paying the price tag for water quality must find innovative ways to raise many billions of dollars in the years ahead. Otherwise, the goals of the Clean Water Act will simply not be met.

As recently as February 18, 1993, during a hearing held before the Environment and Natural Resources Subcommittee of the U. S. House Merchant Marine Committee, Chairman Gerry E. Stubbs (D-MA.) announced to a standing-room-only crowd that he was convening ad hoc meetings for members of the Subcommittee with experts in order to come up "with a specific proposal quickly to provide alternative type of funding" for facility compliance with the CWA. He said he would submit the proposal as soon as possible to the Environmental Protection Agency and the Office of Management and Budget to ascertain whether its viable.

This House Subcommittee hearing activity underscores the dilemma which is facing water and sewer providers, i.e. environmental regulatory compliance must be both achievable and affordable.

SAFE DRINKING WATER ACT REAUTHORIZATION

During the next session of Congress, reauthorization of the Safe Drinking Water Act will be considered. To date, the only two areas Congress has considered are lead in drinking water, and to a lesser extent, radon in drinking water in the context of the Indoor Radon Abatement Act reauthorization. It is likely that water purveyors and the customers they serve will face increased capital, operation and maintenance and monitoring costs in the years ahead, as our elected officials respond to the public's expectation that the food and the water we consume is risk free. The Environmental Protection Agency will continue with its promulgate of rules and regulations, the results of which will be the further identification of additional contaminants which will need to be monitored. It is ironic that technological advances drive some of the concerns about water quality. Twenty years ago we could measure biological constituents in water in parts per million. Ten years ago we could measure in parts per billion, and now we can measure in parts per trillion.

The three major areas of the Safe Drinking Water Act (SDWA) are: 1) standard setting and compliance; 2) enforcement; and 3) groundwater protection. The SDWA of 1974 required EPA to set minimum national standards for drinking water. The 1986 amendments required that standards be set in the form of specific limits on the amounts of biological and chemical substances found in both groundwater and surface water supplies. By 1990, EPA was to have set Maximum Contaminant Levels (MCLs) for 83 specific contaminants, using the Best Available Technology, taking costs into account. Once these regulations were established, EPA set to set MCLs on an additional 25 substances by 1991 and every three years thereafter.

In addition, rules for filtration of surface water supplies were required to remove bacteria and viruses. Overall, the surface water treatment rule, finalized in June of 1989, is potentially the most expensive.

Like the Clean Water Act, larger systems will benefit from economies of scale. Solutions for smaller systems could include regionalization and takeover, in the event individual financial circumstances preclude smaller purveyors from meeting treatment standards. Compliance will be expensive. An example is when EPA finalized its Phase II rule. The cost per statistical cancer case avoided for small systems could be as high as $92 billion nationwide because of the MCLs for alochlor and strizine. And unlike the Clean Water Act which has provided millions of federal dollars for improved sewage treatment, the SDWA provides no money for drinking water treatment upgrades. This lack of funding has become an important political issue.

In May of 1991, EPA's lead rule was finalized, but legislative and court actions are still pending. This rule would not impose an MCL for lead, but instead would establish an action level which could trigger treatment for large systems. Lead service lines could have to be replaced at exorbitant cost, and at-the-tap monitoring would be required. During the rule making process, a major concern expressed by water purveyors was responsibility for circumstances beyond the utility's control in the home. This, once again, incited another political firestorm in which battle lines were drawn as to whether these additional regulations were affordable in comparison to the public health risk.

The proposed disinfection by-products and groundwater disinfection rules are expected to be finalized within the next two years. The costs associated with these rules are largely unknown.

ENDANGERED SPECIES ACT REAUTHORIZATION

As Congress prepares to reauthorize the Endangered Species Act, a number of socio-economic issues must be addressed. The Endangered Species Act (ESA) should be implemented, like other federal laws, to minimize adverse socio-economic impacts. The public should be fully informed of both the benefits and the costs associated with implementation. Public participation should be substantially increased in activities such as listing, critical habitat designation, definition of reasonable and prudent alternatives, recovery plans, and efforts to recover the species.

Improved science will assist in decision-making on protection and conservation of endangered species. The science, at a minimum, should be based on adequate, verifiable information, and should be subject to public, as well as, scientific scrutiny.

Where the ESA results in the taking of private property, the injured person should receive just compensation. The Arizona Legislature, last session, passed a private property rights bill which attempted to ensure that regulatory actions include an assessment of property right impacts. A ballot initiative was successful which will bring precisely this issue to the vote of the people in 1994.

Of specific concern to the Kingman area, is what the ESA reauthorization will do to interstate compacts or U. S. Supreme Court decrees allocating water among states. Implementation must be consistent with State water law and water rights systems, and should assure the use of federal reclamation projects in accordance with their authorized purposes. There are members in Congress who advocate that water should be reallocated for environmental mitigation or enhancement as a matter of federal law, notwithstanding state law or the position that either compensation should be given or value returned to those whose water is used for such purposes.

A compilation of endangered and threatened species within each Congressional District was prepared in December of 1992. The results for Mohave County appear in Volume II. (The report was prepared by William E. Davis, Environmental Consultant, and EcoPlan Associates, Inc., of Mesa, Arizona. This document is a matter of public record.)

An "endangered species" is any species in danger of extinction throughout all or a significant portion of its range. A "threatened species" is any species likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

STATE HEALTH BASED GUIDANCE LEVELS

The Arizona Department of Environmental Quality (DEQ) publishes guidelines for maximum contaminant levels for human ingestion of drinking water. These levels are designed to ensure that the public health is protected. A copy of the State's Health Based Guidance Levels can be referenced in Volume II.

ENVIRONMENTAL SUMMARY

Municipalities and public agencies should pay close attention to federal activities with potential impacts on water costs and water rights. As to quality, the public expects that there be zero risk, not "small risk", or "limited risk", or "comparative risk". In reality, zero risk is seldom achievable or affordable. As to quantity, reallocation of water resources must be weighed against and balanced with private property rights and state law. Government must ask its citizens what they want in terms of environmental protection. There must also be clear indications of both the costs and benefits. Informed thought should be given to what is sustainable development, given environmental sensitivities. The state has attempted to address this important issue through the Arizona Comparative Environmental Risk Committee analysis of public values and how the environment fits into people's lives.

POLITICAL AND INSTITUTIONAL FACTORS

WATER LEGISLATION

Kingman must monitor state legislative initiatives to ensure that water resource proposals do not adversely impact future planning. Recently, a bill was introduced in the State Senate which includes a provision that "groundwater may not be transported away from a groundwater basin". This type of restriction would seriously impair Kingman's ability to develop additional groundwater supplies from the Sacramento basin for transfer to and use within the Hualapai basin, or Hualapai supplies being used for Sacramento basin sited development. Amendment language should resolve the problem; however, this example illustrates that the City still needs to be diligent on the legislative front. There is still a need to protect local water supplies from being exported to other areas outside the planning boundaries; however, it is important to guard against unexpected consequences of what appears to be sound legislation.

Regular contact with State legislators is recommended. Any bill containing the words "water", "wastewater", "surface water", or "ground water", should be examined closely in order to determine what impacts may exist.

COUNTY WATER AUGMENTATION AUTHORITY LEGISLATION

There have been discussions, over the past several years, regarding formation of a Mohave County water augmentation authority. This dialogue was, in part, a response to the groundwater transfer debate between rural Arizona, that wanted to protect local water supplies for their own future growth, and urban centers, that needed additional supplies in order to comply with assured water supply and safe yield goals of the active management areas. The result was state legislation that defined open, reserved and closed basins; and which provided for formulation of the Phoenix Groundwater Replenishment District and Santa Cruz Water Authority.

The goal of an augmentation authority is supply development. Additional goals may include control of severe groundwater overdraft and allocation/reallocation of resources. If the political support is sufficient to form such an entity, certain elements must be contained in the legislation, including:

1. criteria to form the augmentation authority;
2. establishment of jurisdictional boundaries;
3. allowances for court action to appeal formation;
4. conference upon the authority the status and rights of a municipal corporation;
5. establishment of membership;
6. definition of administrative powers and duties of the officers/board;
7. establishment of abilities to contract with other governmental agencies;
8. enumeration of powers;
9. enumeration of prohibitions;
10. establishment of funding, bonding and financing criteria;

11. adoption of administrative and operating budgets and functions; and,

12. other appropriate provisions.

Before Kingman can make any decision as to whether an augmentation authority should be formed, the City must determine if it can fulfill all service area obligations by itself - looking at achievability and affordability. Based on existing and proposed authorizing legislation for other districts/authorities, it appears that these types of entities can fulfill the area-specific water development needs by effectively pooling financial resources of both the public and private sectors.

LEGAL FACTORS

WATER ADEQUACY RULES AND REGULATIONS

The Arizona Department of Water Resources is in the process of promulgating rules to implement the Assured and Adequate Water Supply programs mandated by Arizona's Groundwater Management Act. The premise being that a safe, reliable, sustainable water supply is a key component of healthy economic development. Since the Kingman service area is outside an Active Management Area, it is subject to water adequacy requirements. Under the Water Adequacy Supply program, a develop must either demonstrate an adequate water supply or disclose to potential buyers that one does not exist. The developer is relieved from this burden, if service is provided by a city, town or private water company. The City, as the water purveyor, works closely with development interests in showing full compliance.

The reason for this legal criteria is to protect the buying public. Historically, Arizona had a problem with land fraud whereby lots were sold with little or no chance of having water delivered. Prior to 1973, no state law required subdividers to disclose whether a local water supply existed or was adequate. Laws passed in 1973, required sellers of subdivided land to submit to the Arizona Water Commission (the predecessor to the Arizona Department of Water Resources) water plans which were then evaluated.

Under new legislation passed in 1973, the Water Commission developed three criteria for determining whether a water supply was "adequate" for a proposed development. The subdivider had to demonstrate:

a) there was at least 100 years of water supply available;

b) there would not be more than a 10-foot annual decline in the groundwater level; and

c) the projected depth to groundwater after 100 years would not be more than 1,200 feet.

A subdivider who cannot demonstrate an adequate water supply may still market the property, but the lack of an adequate water supply must be disclosed in all marketing, advertising and promotional materials.

Even though the draft rules have not been finalized, for planning purposes it is recommended that Kingman proceed under the assumption that the specified, or similar, criteria will be forthcoming. In addition, the water adequacy criteria represents sound resource management goals that the City should be pursuing, regardless.

SPECIFIED ADEQUACY CRITERIA

"Physical availability" addresses the statutory criterion that sufficient quantities of water must be continuously available to satisfy the water demand of the development for 100 years. The word "availability" includes physical, continuously and legal availability of the identified supplies of water. Sources of water identified are groundwater, surface water, Central Arizona Project water, Colorado River water, effluent, and storage and recovery projects water. This requirement also reflects the need to have both a dependable supply and delivery and treatment works to meet water service demand.

Physical availability - the volume of groundwater available for determinations of water adequacy is based upon a 100 year supply from existing service area wells or service area wells likely to be constructed in the future. Outside active management areas this volume is limited to a 1200 foot depth-to-static water level. Availability of Colorado River water (other than Central Arizona Project water) is based upon one hundred percent (100%) of the executed contract amount. And finally, availability of effluent is based upon an analysis by the DWR Director of the current and projected production figures, the applicant's capacity to treat the effluent, and the demand for the effluent.

If the proposed source is groundwater, the Director shall determine the volume of groundwater which will be available for the proposed use for one hundred years from wells owned by the applicant or the municipal provider. These wells will serve the applicant on the date of application within the applicable service area and wells which the Director determines are likely to be constructed for future uses by the applicant or municipal provider proposed to serve the applicant within the applicable service area.

In determining the quantity of groundwater available from each well, the applicant shall use a method of analysis approved by the Director. The Director shall only consider groundwater to be physically available if the groundwater is to be withdrawn from depths not to exceed the 1200 feet below land surface. This is the standard applied to areas outside of active management areas/developments other than dry lot developments, which includes Kingman. The Director shall determine the 100 year depth-to-static water level by adding:

(1) the depth-to-static water level on the date of application for the area from which the groundwater withdrawals are proposed;

(2) the projected decline in the depth-to-static water level for the area from which groundwater withdrawals are proposed during the one hundred year period after the date of application, calculated using records of declines for the twenty-five years previous to the date of application as adjusted by evidence of changes in pumpage patterns and aquifer conditions; the projected decline in the depth-to-static water level for the area from which groundwater withdrawals are proposed to occur during the one hundred year period after the date of application attributable to the projected groundwater demand of other platted subdivisions that are entirely unoccupied, those portions of other platted subdivisions which are unoccupied or other developments . . . only groundwater withdrawals which will affect groundwater availability in the vicinity of the proposed water service shall be considered for purposes of this subdivision; and, the decline for the area from which groundwater withdrawals are proposed which the Director projects to result from the applicant's proposed use over a one hundred year period.

The Director may lower the 100 year depth-to-static water level requirements specified . . . for withdrawals outside of active management areas (such as Kingman), if the Director determines that groundwater is available at the lower depth and the applicant demonstrates the financial capability to obtain the groundwater. The Director shall not consider groundwater to be physically available if the withdrawal of such groundwater would have a negative impact on surface water rights.

If the proposed source of water is Colorado River water: the Director shall calculate the quantity of water available for the proposed use by multiplying one hundred percent (100%) of the contracted annual amount of water by one hundred for an applicant that has a contract with the United States Secretary of the Interior for domestic water.

If the proposed source of water is effluent the Director shall estimate the volume of effluent which will be available to the applicant for one hundred years by evaluating the metered production or calculated production of effluent. The Director may limit the volume of effluent estimated when taking into account the applicant's projected demand for effluent, requiring that effluent use shall be in accordance with any applicable quality standards established by the Arizona Department of Environmental Quality.

Evidence of continuous availability must be submitted pertaining to adequate storage, delivery, and treatment works for the proposed supply are in place or will be constructed in a timely fashion; and to ensure that groundwater is available on a continuous basis rules will require wells to be of adequate capacity to meet the projected demands on a continuous basis; surface water supplies must be perennial at the point of diversion unless alternative supplies or adequate storage are available; and supplies of effluent must not be affected by seasonal fluctuations. Legal availability of water must be demonstrated: there must be a right to pump groundwater; where the proposed source is Colorado River water (other than C.A.P.), the applicant must present evidence of a contract for the water with the Secretary of the Interior; and that effluent is treated to the levels legally required for end-use.

"Water quality" addresses the statutory criterion that the water must be of adequate quality, in that supplies must meet all applicable state water quality standards. Outside the scope of the Groundwater Management Act, is the need for quality to meet federal Clean Water Act and Safe Drinking Water Act standards, as well.

"Consistency with Management Goal" addresses the statutory criterion that the proposed use must be consistent with the management goal of the specific Active Management Area (AMA). Kingman, being located outside an AMA, is not subject to these goals; however, as a matter of State policy there are inherent obligations to management resources wisely, to conserve water, to reuse water when appropriate and to protect the health and well-being of the citizens. As indicated previously, the Department will be looking at the total resource picture of the planning area.

"Consistency with the Management Plan" provides that each assured water supply application will be reviewed to ensure that the water use patterns of a proposed development or designated area will be consistent with the conservation requirements of the applicable management plan. Again, Kingman is not subject to this provision because it is located outside an AMA. Conservation is still a key element when addressing any Department decision-making. Good resource management dictates that savings be generated wherever possible and that potable supplies be protected.

"Financial capability" provides criterion to list the types of evidence the Director will consider in determining whether an applicant has sufficient financial resources to construct the delivery system and any treatment works required for the proposed use. Criteria for dealing with "extensions" of service areas will have to be addressed as part of separate state omnibus legislation. The City of Kingman has groundwater, Colorado River contract water, and effluent immediately available for use within its current service area and future planning area. Willdan has calculated and analyzed the various resource mix alternatives which will ensure that water adequacy criteria will be met.

FEDERAL RECLAMATION LAW

The Department of Interior is the federal agency responsible for the Colorado River. Its decision-making will be conducted with the public's best interests in mind. Subjective and objective approaches will be used that goes beyond just the technical contract administrator role. Water resource use and development up and down the entire river system will be considered.

There have been numerous discussions regarding the prior appropriations doctrine in Arizona. This doctrine provides that the first in time - is first in right. Senior water right holders must be satisfied before any junior claimants can receive water. This senior right can be relinquished by declaration or forfeited by non-use or abandonment. Water experts in Arizona are of the opinion that the Santa Fe Compact (Colorado River Compact) and the laws of the river (resulting from the various court actions) supersedes the prior appropriations doctrine as to federal contract Colorado River water. The federal government may feel differently. At issue is whether a federal contract is permanent in nature, and whether non-use can justify reallocation of the resource even though financial obligations are being met and review has been effectuated. This discussion has come to light in the context of resolution of the Central Arizona Project underutilization problem.

The only way to ensure that the contract is protected is by directly using the resource. In the alternative, the federal government will look to see if future demand can be cost-effectively serviced by development of the resource within some reasonable length of time. Common sense should prevail. With a number of competing interests along the River for water, it is doubtful that the Kingman contract will stay open-ended much longer. A pragmatic decision will be made based on the realistic assessment of actual or potential use.

The federal government will not tolerate any manipulation of water rights. That is why in December of 1992, the Bureau of Reclamation released draft regulations for administering entitlements to Colorado River water (provisions are previously mentioned in this report). These draft regulations should be finalized and promulgated within 18 to 24 months. Parameters will be established as to what contract holders can, or cannot, do with their respective allocations.

There is no question that Kingman will need additional water supplies in the future. The problem is that growth will not occur soon enough so as to provide the financial foundation upon which to build the requisite infrastructure to take and use water directly. There are more than sufficient groundwater supplies available for the future. The City must weigh the reality of embarking upon an extremely expensive program to develop its Colorado River water against other less-costly options that still retain the integrity of the city's water future.

The Department of Water Resources, in various discussions, has indicated that the Kingman contract water must stay within Mohave County, if it is not used within the City's current service area and future planning area. The chances of this water going elsewhere outside the County is remote, given the tremendous growth. Kingman must work with other interested water users within Mohave County to put this water to beneficial use as soon as possible.

There have been discussions at the federal level about "water banking", which would allow for the movement, use and storage of supplies among various entities, subject to negotiations. A more localized banking scenario could be developed with interested parties. Depending on the structure, this concept may provide Kingman, and other purveyors in similar circumstances, with the opportunity to take water and deposit it into "bank accounts". The water developed could then be withdrawn in the future. The problem with this program is where do you put the water? If the contract water is banked in storage behind Hoover Dam, there would be opposition from Central Arizona Project beneficiaries because banked water would adversely affect C.A.P. water availability, and more importantly, reliability. C.A.P. water has the lowest priority on the Colorado. If water is stored on the system that has a higher priority, that water would have to be delivered before C.A.P. when a demand is made. This type of water resource tool is being addressed in the draft federal rules for administration.

An alternative would be to have right holders who need more water soon, to assist Kingman financially with additional groundwater development in "exchange" for the right to receive either "banked water" or the contract water itself for their own site-specific needs. This approach to resource management is based on the precedence established with C.A.P. exchanges and related Indian water rights settlements. It was originally anticipated that C.A.P. allotees located outside the tri-county service area of Pima, Pinal and Maricopa counties would be able to effectuate up-stream exchanges whereby one water supply could be diverted locally, in exchange for the individual C.A.P. sub-contract water going elsewhere. These "exchanges" would be necessary due to the significant costs involved with developing direct C.A.P. water delivery. Subsequent problems arose with the up-stream exchanges themselves. Exchanges could not be facilitated because of environmental prohibitions and water rights adjudication issues.

The issue now became whether financial resources could be exchanged rather than water resources. On March 11, 1993, the Board of the Central Arizona Water Conservation District (the entity responsible for operation of C.A.P. and repayment to the federal government of all reimbursable costs) approved an "exchange" of Payson's C.A.P. sub-contract entitlement. North Scottsdale developers will provide the entitlement to the City of Scottsdale which, in return, will waive its water resources development fee. The Town of Payson would receive funds to develop an alternative water supply for its service and planning area.

ADWR is proposing policy guidelines for C.A.P. "exchanges", that could have application in other areas of the State, including Mohave county. The goals should be to maximize use of the State's Colorado river allocations, and to provide local purveyors with cost-effective water resource options for the future. The criteria as drafted by the Department is contained in Volume II.

WATER RESOURCE ALTERNATIVES

In the Kingman Project Concluding Report of April 1971, which was prepared by the Bureau of Reclamation, the problems and needs of the area were identified. It stated: "The basic problems of the area, like those of the Region as a whole, are threefold. First, local water supplies are generally inadequate to support projected population growth on a sustained basis; second, the only permanent means for augmenting local supplies (ground water) is by the construction of expensive pumping and conveyance works from the nearest available surface source of supply, the Colorado River; and third, capital expenditures for such water supply works must be made years in advance of the time when the population can utilize the full capacity and will have the necessary tax base (and also ratepayer base) for economic repayment of project costs."

The Report concluded that the use of Colorado River water would be required in the future (an actual projection of use by the year 2020 was made), but that at present (1971) the continued development of local ground water is economically more attractive until growth of the area can support the cost of the relatively more expensive Colorado River supply.

This conclusion has applicability today, except that the hydrogeologic data developed in conjunction with this study, coupled with previously developed data from other studies, gives the City a much more extensive picture of the ground water supply in terms of quantity and quality. The ground water conclusions as to the potential for development are contained in Chapter Three and in the hydrogeologic report, which is included as Appendix A in this volume.

SERVICE AREA DIRECT USE OPTIONS (DIRECT DELIVERY AND RECHARGE)

The City of Kingman has two direct-delivery options that it can pursue. The first option is to construct the necessary transmission and treatment infrastructure so that Colorado River water can be delivered directly to service area customers. Cost estimates for construction of the requisite pipeline, pumps, lift stations and treatment works were developed in the original 1971 Kingman Project Concluding Report. Willdan reviewed those figures and recalculated the infrastructure cost based on 1993 dollars for both the Lake Mohave/Highway/Kingman

Alignment route and the Lake Mead/Red Salt Cavern/Kingman Alignment route. These costs are presented in Chapters Four and Seven of this report.

It is apparent that lower or shared cost alternatives should be pursued for direct delivery. Other construction and funding opportunities that did not exist in 1971 were evaluated, including those specific proposals that were brought to the City. In direct discussions with the Bureau of Reclamation, Willdan made specific inquiries as to availability of federal funding for project development. There are funds contained in the Small Reclamation Loan Program (SRLP); however, there is an express requirement that there be an irrigated agricultural component. In addition, SRLP monies are loaned with a market-rate repayment obligation. The City could obtain lower repayment rates through utilization of any tax-exempt municipal financing authority it has available. If no spending authority exists, the City could not pursue the direct delivery construction option regardless.

The second option, which was not fully addressed in the 1971 Report, is construction of the necessary infrastructure, either injection wells or spreading basins (and including the transportation/delivery system from the points of diversion), so that Colorado River water can be recharged within the service area to rehabilitate ground water aquifers and to store water underground for future use. The cost of direct recharge would be less than the direct treatment and delivery option, however, it would still be cost prohibitive.

DIRECT DELIVERY TO OTHER MOHAVE COUNTY USERS OPTION

In the event the City can not use its Colorado River allocation directly, alternative options need to be developed. The first step is to identify other Mohave County end-users that may have a need for Kingman's allocation and would be interested in pursuing transfer, exchange, wheeling, interim storage, lease or other value-returned arrangements:

- those with Colorado River contracts;
- those without Colorado River contracts, both public and private sector entities;

- Native American water rights settlement requirements;

- Replenishment District or Augmentation Authority (if such an entity were formed for Mohave County); or,
- Federal purposes, such as fish and wildlife restoration or recreation.

- State purposes, instream flow or State Land development.

The Arizona Department of Water Resources has a pool of unallocated water (approximately 30,000 acre-feet from the State's 2.8 million acre-feet), which it has designated for use along the River. There is an expectation that future growth can be serviced from this "reserved supply". There is also an assumption, based on discussions with appropriate DWR staff, that any water not used by individual allotees would remain within the county of origin, unless there is either a lack of demand, or a lack of ability to development the resource.

DIRECT DELIVERIES TO OTHER NON-MOHAVE COUNTY USERS

In addition to the options within Mohave County, there are also options that can be pursued with entities with water use needs outside the exterior boundaries of Mohave County, including:

- those with Colorado River contracts;
- those without Colorado River contracts; both public and private sector entities;

- Central Arizona Project Sub-contractors/reallotees;

- Central Arizona Water Conservation District;

- Native American water rights settlement requirements;

- Phoenix Active Management Area Groundwater Replenishment District of other local districts (when formed);

- Santa Cruz Water District (Pima Active Management Area);

- Federal purposes, such as fish and wildlife restoration, recreation, Yuma desalter make-up water, pump-back storage use, etc.

- State purposes, instream flow or State Land development.

POWER ACQUISITION

In an attempt to examine innovative ways to develop the best possible resource base for Kingman, Willdan has examined the possibility for the City executing its contract for Colorado River water with the expectation that this "asset" can later be used to acquire lower cost energy through some type of future resource exchange. Most of the preference power contracts now allocated to electrical districts and other public power contractors throughout Arizona are up for renewal or reallocation in the year 2017. If Kingman continues to rely predominantly on groundwater, it would serve the City's interest to secure the lowest cost energy supply for well pumping purposes, and this means preparing itself now for such pursuit. The Arizona Power Authority administers federal preference power generated through the Western Area Power Administration.

It is also possible for the 18,500 acre feet to be utilized for the operation of the Spring

Canyon Pumped Storage Project. The Bureau of Reclamation has determined that once this project is fully operational the annual consumptive use will be approximately 12,000 acre feet. Kingman may consider an agreement whereby its water could be used in exchange for hydrogeneration benefits.

SUMMARY AND RECOMMENDATIONS

State law protects water entitlements, since the original allocations where based on State recommendations. It would be inappropriate for the State to now support a use it or lose it approach because the water will be needed at some time in the future. The State would support a reallocation within the County, so as to protect the water resource integrity and not impede growth potential. So long as Kingman continues to pursue active planning and decision-making for its water future, both the State and Federal Government should be satisfied.

The City must be realistic as to its ability to finance the necessary infrastructure for direct transportation, treatment and delivery of its Colorado River allocation. Even though the need for that water does not now exist, there is a reasonable expectation that the need will develop over time; therefore the supply must be protected. Political and financial commitment are sufficient to manifest Kingman's intent to use this water. By finalizing execution of its contract, the City then incurs the legal obligation to use this water. If Kingman accepts this obligation, it is recommended that a separate, designated fund be generated to begin accumulating monies for the inevitable likelihood that infrastructure will be constructed in the future.

If however, the conclusion is that there are sufficient groundwater and effluent resources available to ensure a safe, reliable water supply for the future, and that the cost is less expensive than direct contract water development, Kingman should pursue with other Mohave County entities the options of using the precedence established with C.A.P. exchanges. If there is no demand or interest for this water within the County, then the City can explore other uses along the Colorado River. Preliminary indications are that there is an interest and a need for this water. Only as a last resort should the City seek alternatives away from the Colorado River.

It is recommended that Kingman approach other water users within the County to determine which entities would be willing to receive all or portions of the contract water, in exchange for funding of future groundwater system expansion, effluent reuse, programmatic water conservation and related staffing. Specific projects could include, but are not limited to:

1. well field enhancements and expansion pursuant to recommendations contained in previous studies;
2. drilling of test wells for water quality monitoring and identification of alternative groundwater development locations;
3. construction of effluent return lines for irrigation of turf facilities and for industrial cooling;
4. construction of effluent recharge facilities;
5. implementation of various water conservation programs, such as retrofit, public education, rebates, leak detection, etc.;
6. water loss studies; and,
7. funding for a water resources planner and/or conservation coordinator position/positions.

CHAPTER SEVEN

ECONOMIC FEASIBILITY ANALYSIS

FINANCING ALTERNATIVES

Financing public works projects is typically the team effort of the City's staff and elected officials, municipal bankers, bond counsel, and the consulting engineers. The financing of projects includes two components: the financing vehicle and the source of debt repayment. For water and wastewater projects, the following financing alternatives should be considered:

<u>General obligation bonds.</u> General obligation bonds required voter authorization. The bonds are typically issued for a fifteen to twenty year period, and require semi-annual interest and principle payments. Even though a municipality may meet these payments with revenue sources (such as those from a water or sewer system), the bonds are secured by the ability of the City to levy taxes against real property.

<u>Revenue bonds.</u> Revenue bonds also require voter authorization. The bonds have the same terms as general obligation bonds, but are secured by a pledge of highway user taxes, water or sewer system revenues. Since they are less secure than general obligation bonds, they usually bear a slightly higher interest rate.

<u>Quasi-governmental organization bonds.</u> Quasi-governmental organizations bonds do not require voter authorization. The bonds have the same terms as general obligation and revenue bonds, but are issued under the auspices of a non-profit corporation established by the municipality (such as a Municipal Property Corporation). The non-profit organization holds title to the asset constructed or acquired, and leases it back to the

City, which makes semi-annual lease payments in the amount of the bond principal and interest payments. Even though a city may meet these payments using water or sewer system revenues, the bonds are secured by a pledge of sales tax revenues and other non-property tax revenues. They usually bear a slightly higher interest rate than revenue bonds.

Improvement district bonds. Some municipalities finance utility system acquisitions or improvements through improvement districts. Improvement districts assess each parcel in a specified area based upon the parcel's relative benefit received from the project. Approval by affected parcels is required, and terms of these bonds are similar to general obligation or revenue bonds. An additional feature of improvement districts is the opportunity afforded to property owners to pay an assessment in advance, thus avoiding bond issuance and interest costs.

Lease-purchase arrangements. Lease-purchase arrangements for fixed assets were frequently used by municipal governments until recent tax code changed made them more complex. However, with a properly structured arrangement, it is still possible for a capital improvement be financed with this type of vehicle.

Developer construction Municipalities often require developers to construct portions of utility systems which have a capacity greater than that required by the developers' projects. The City and the developer enter into a repayment agreement whereby future projects connecting to that portion of the utility system pay the developer a share of the costs of construction.

Federal loan programs Although it is difficult for municipalities to obtain federal grants, federal loan programs do exist for water and wastewater system improvement and expansion. The program offered by the Farmers Home Administration is similar to an improvement district, and is widely used throughout Arizona. The City is presently taking advantage of the revolving loan program offered by EPA and Arizona DEQ. This program, which is relatively new, permits a municipality to borrow funds one to two percentage points below the current market rate for tax exempt bonds.

The repayment of debt on the aforementioned financing vehicles can be from a variety of sources:

<u>User fees</u> Water and sewer user fees can be developed to include both operating and capital components. The operating component covers the normal operation, maintenance and administrative costs of the system. The capital component covers debt service payments, pay-as-you-go improvements, and replacement of major system items which fail due to age or use. User fees can be tied through covenants to revenue bonds, or can be tied through the budget process to one of the other financing vehicles.

<u>Development fees</u> In accordance with A.R.S. 9-463, a municipality may impose a development impact fee on new development which may be used to either pay for the costs of system expansion, or may be used to retire debt incurred for system expansion which directly benefits the development. Some municipalities encourage a developer to pay these fees in advance through negotiated discounts.

<u>Assessments</u> Lump sum assessments are made to repay debt incurred through improvement districts or certain federal programs. These assessments are based upon the benefit the property receives from the project.

WATER RESOURCE EXCHANGE

Chapter Six of this report presents in detail a plan for exchanging the City's Colorado River allocation for groundwater or effluent reuse development within the Kingman area. This alternative should be aggressively pursued by the City, as it affords the opportunity for immediate development of water resources ahead of the actual need for water as a result of future growth. However, if this exchange is not possible, delayed, or devalued, the City will be required to consider other revenue sources for water resources development.

The City may desire to seek exchange opportunities for all of its Colorado River allocation or for only a part of it. If only a portion of the water is exchanged, the resulting funding could be utilized to transport the remaining allocation to the Kingman area. That water could then be either used directly or recharged into the aquifer. However, based upon the costs of transporting water, and the available supply of groundwater in the Kingman area, this alternative does not appear to be practical.

WATER RESOURCE CAPITAL COSTS

As discussed in Chapter Four, the City has several alternatives for water resource development. The capital costs of these alternatives are presented in Exhibit 7-1. For comparative purposes, all costs are presented on a per-acre foot basis. As can be observed, per acre foot costs range from $288 (wellfield development) to $3,598 (use of existing pipeline). The average cost is $1,110 per acre foot for all water resource alternatives.

CITY OF KINGMAN
WATER ADEQUACY STUDY
SUMMARY OF WATER RESOURCE CAPITAL COSTS

RESOURCE ALTERNATIVE	INFORMATION SOURCE	COST PER ACRE FOOT
Wellfield Development	Carollo Report (Willdan update)	$288
Import from Lake Meade	TranAm (Willdan update)	$876
Import from Lake Mohave (via highway)	BOR (Willdan update)	$718
Import from Lake Mohave (via Duvall)	BOR (Willdan update)	$814
Existing Pipeline	Four Corners Pipeline	$3,598
Effluent Reuse	Carollo Report (Willdan update)	$364
AVERAGE COST PER ACRE FOOT		$1,110

EXHIBIT 7-1

WATER RESOURCE DEVELOPMENT FEE

To fund the acquisition of additional water resources, development fees appear to be a viable alternative. Development fees are permissible under the provisions of ARS 9-463.05, which establishes the following requirements:

The fee must benefit the development for which it is assessed. The development must need the infrastructure or capital projects the fees are used to construct. For example, a city was not permitted to collect fees for neighborhood park acquisition and construction when the developer had included similar facilities as part of a condominium complex.

The fee must be segregated from other funds and can only be used for the purpose for which it is collected. Some cities use a separate bank account for the fees, but this is not necessary, since separate accounting will suffice. However, other funds cannot "borrow" from the development fee fund, and the fund should be credited with the interest it earns on investments. Also, the fund can pay directly for construction projects, or can be used to pay for debt service for these projects.

The fee is collected when construction permits are issued. This prevents the fee from being collected in the subdivision approval process, although some developers have paid fees early to avoid increases.

The fee must be based upon the actual cost to the City to provide the services to the new development. This requires a methodological study to support the fee.

The fee cannot discriminate. This precludes the municipality from using the fee to control zoning activities. For example, a fee cannot be charged to an adult bookstore or other undesirable business if the same fee is not also charged to a real estate office or other desired business.

The fee cannot duplicate monies collected in an improvement district or community facilities district process. This precludes the double charging of fees.

Thirty days advance notice for new fees or fee increases is required, and a public hearing must be held at least two weeks before the City Council votes on the fee. This permits the development community time to react to fees or increases.

As previously observed, the City has three potential water resources:

1. surface water importation
2. groundwater resource development
3. effluent reuse

As presented earlier in this chapter, the cost of an acre foot of water ranges from \$288 to \$3,600, or averages \$1,100. About 164,000 gallons of water, or one half of an acre foot, is required annually to support a typical single family residence. The City can use several methods to establish the actual cost per single family residence for water resource development:

The fee can be based upon the actual source of water used for the development. In this instance, the groundwater based fee would be about \$144 per residence, the importation fee would be \$670, while the reuse based fee would be \$182. The central problem with this approach is that it discourages timely development of effluent reuse facilities.

The fee can be based upon a "market approach". Using the market approach is difficult, since only three other communities in Arizona have adopted a water resource development fee (Peoria, Phoenix and Scottsdale), and none of these cities are directly in the Kingman market area. However, a market analysis is often a good indicator of the reasonableness of a fee. In this instance, the market trend appears to be about $1,000 per single family residence.

<u>The fee can be based upon the hybrid costs of acquiring water resources.</u> Using this approach, a single family residence fee of $500 can be justified. Since this fee encourages the development of all water resources, and since it compares favorably with the market approach, it is recommended for consideration by the City.

The application of the fee to other than single family residential development requires additional analysis. Two basic approaches are available:

<u>Progressive fees can be based upon the amount of water required by a specific non-single family residential development project.</u> This approach, while perhaps the most equitable, requires a complex analysis each time a project is presented for permitting. Uniformity of analysis is essential, but cannot be guaranteed.

<u>Progressive fees can be based upon the size of water meter required for a project.</u> The American Water Works Association has already established demand standards for various sizes of water meters. Exhibits 7-2 through 7-5 present the fee structures for these larger meters, using the groundwater development, reuse, and hybrid fee bases.

A suggested ordinance for implementation of a water resource development fee is included in Volume II of this report. Fees should be reviewed annually to ensure that they meet the financial and operational needs of the City.

CITY OF KINGMAN
WATER RESOURCE DEVELOPMENT FEE ALTERNATIVE
FEE BASIS: COLORADO RIVER IMPORTATION

METER SIZE	DEMAND FACTOR	FEE AMOUNT
5/8" x 3/4"	1.00	$670
1"	1.40	$938
1 1/2"	1.80	$1,206
2"	2.90	$1,943
3"	11.00	$7,370
4"	14.00	$9,380
6"	21.00	$14,070
8"	29.00	$19,430

EXHIBIT 7-2

CITY OF KINGMAN
WATER RESOURCE DEVELOPMENT FEE ALTERNATIVE
FEE BASIS: EFFLUENT REUSE

METER SIZE	DEMAND FACTOR	FEE AMOUNT
5/8" x 3/4"	1.00	$182
1"	1.40	$255
1 1/2"	1.80	$328
2"	2.90	$528
3"	11.00	$2,002
4"	14.00	$2,548
6"	21.00	$3,822
8"	29.00	$5,278

EXHIBIT 7-3

CITY OF KINGMAN
WATER RESOURCE DEVELOPMENT FEE ALTERNATIVE
FEE BASIS: GROUNDWATER DEVELOPMENT

METER SIZE	DEMAND FACTOR	FEE AMOUNT
5/8" x 3/4"	1.00	$144
1"	1.40	$202
1 1/2"	1.80	$259
2"	2.90	$418
3"	11.00	$1,584
4"	14.00	$2,016
6"	21.00	$3,024
8"	29.00	$4,176

EXHIBIT 7-4

CITY OF KINGMAN
WATER RESOURCE DEVELOPMENT FEE ALTERNATIVE
FEE BASIS: HYBRID APPROACH

METER SIZE	DEMAND FACTOR	FEE AMOUNT
5/8" x 3/4"	1.00	$500
1"	1.40	$700
1 1/2"	1.80	$900
2"	2.90	$1,450
3"	11.00	$5,500
4"	14.00	$7,000
6"	21.00	$10,500
8"	29.00	$14,500

EXHIBIT 7-5

HYDROGEOLOGIC REPORT

KENNETH D. SCHMIDT AND ASSOCIATES
GROUNDWATER QUALITY CONSULTANTS
1540 EAST MARYLAND, SUITE 100
PHOENIX, ARIZONA 85014
602-279-7033

April 13, 1993

Mr. Mike Moore
Willdan Associates
1717 W. Northern Avenue
Suite 112
Phoenix, Arizona 85021

Re: City of Kingman Groundwater Evaluation

Dear Mike:

Submitted herewith is our final report on the potential for groundwater development in the vicinity of the City of Kingman. We appreciate the cooperation of Willdan Associates and City staff during this evaluation.

Sincerely yours,

Ken Schmidt

Kenneth D. Schmidt

KDS/d

POTENTIAL FOR DEVELOPMENT OF GROUNDWATER FOR PUBLIC SUPPLY IN THE VICINITY OF THE CITY OF KINGMAN, ARIZONA

FINAL REPORT

Prepared for:

WILLDAN ASSOCIATES
Phoenix, Arizona

Prepared by:

KENNETH D. SCHMIDT AND ASSOCIATES
Groundwater Quality Consultants
Phoenix, Arizona

April 13, 1993

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POTENTIAL FOR DEVELOPMENT OF GROUNDWATER FOR PUBLIC SUPPLY IN THE VICINITY OF THE CITY OF KINGMAN, ARIZONA

INTRODUCTION

The City of Kingman is presently evaluating potential future water supplies for the City, including groundwater. The evaluation focuses on two areas that were selected near the City. The first is the Upper Hualapai Valley, in which the City Airport well field is located. The area selected for this study is approximately bounded by the City on the southwest, Long Mountain on the north, the Cerbat Mountains on the west, and the Peacock Mountains on the east. The second area evaluated was the part of the Sacramento Valley primarily in T20N and T21N. This area is bounded by the Black Mountains on the west and the Cerbat Mountains and Hualapai Mountains on the east and is locally called "Golden Valley". Because of the desirability of developing a long-term water supply in an area with adequate well yields, alluvial deposits in the valley parts of these study areas were the focus of this evaluation. In this report, the Upper Hualapai Valley is discussed first, followed by the Golden Valley.

GROUNDWATER CONDITIONS IN UPPER HUALAPAI VALLEY

Regional groundwater conditions in this area were evaluated by Gillespie, Bentley, and Kam (1966), Gillespie and Bentley (1971), and Remick (1981). Robertson (1991) evaluated the geochemistry of groundwater in a number of alluvial basins in Arizona, including the Hualapai Valley. Several groundwater evaluations have been conducted for the City of Kingman. One was of the Hackberry area, northeast of the study area for this evaluation, by Thiele (1962). Another was of the study area itself, which was termed the Airport Basin by Thiele (1968). More recently, Cella Barr Associates (1990) evaluated the Hualapai Valley. A water supply evaluation was performed for the Cerbat Water Co. certification area, which is north of Kingman, by Manera (1980).

Subsurface Geologic Conditions

Rock outcrops in the vicinity of the City are primarily Tertiary volcanic rocks, and some of these rocks extend beneath the valley floor. In some areas, including the City, wells tapping these rocks are moderately productive but the amount of groundwater in storage is limited. Rock outcrops forming the Cerbat and Peacock Mountains bounding the valley are primarily igneous intrusive and metamorphic rocks. These crystalline rocks or volcanic rocks form the effective base of the alluvial groundwater system in the Upper Hualapai Valley.

Thiele (1968) developed a number of subsurface geologic cross sections in the area, based on a detailed electrical resistivity survey and logs for several wells that were available at that time. Thiele (1968) indicated that the igneous intrusive and metamorphic rocks and some relatively unfractured volcanic rocks at depth, clay facies in some of the alluvial deposits, and relatively deep water levels were the primary constraints in finding suitable sites for large-capacity wells. He recommended the sites where City Wells No. 2, 3, 4, 5, and Long Mountain Well No. 6 were eventually drilled. He delineated two major inferred buried stream channel deposits trending generally parallel to Highway 66 (Figure 1). The northwestern of these is where City Wells No. 2, 3, 5, and Long Mountain Well No. 6 are located. The southeastern one underlies the airport vicinity and is where City Well No. 4 is located.

Oppenheimer and Sumner (1980) presented the results of two gravity profiles that were run and the results of gravity modeling in the Upper Hualapai Valley. Profile 9-5 trended from west to east and passed through the south end of the airport. Profile 9-4 trended from southwest to northeast and extended through the north part of the study area. Interpretation of the results of these surveys and gravity modeling allowed preparation of a depth to bedrock map. Bedrock was defined as rock with a density of 2.67 grams per cubic centimeter. The volcanic rocks that are interlayered with the alluvium are considered part of the alluvial deposits. Otherwise they are considered bedrock.

This map indicates that bedrock is more than 4,000 feet deep beneath the central part of the study area, including the eastern part of the airport. Depth to bedrock decreases rapidly to the south and east, to less than 400 feet near the edges of the study area. For purposes of this evaluation, areas underlain by bedrock deeper than about 1,600 feet are considered more favorable for groundwater development, and are delineated in Figure 1.

As part of this evaluation, two subsurface geologic cross sections were developed (Figure 1). Cross Section A-A' (Figure 2) trends parallel to Highway 66, and extends from City Well No. 3, through City Wells No. 2 and 5 and Long Mountain Well No. 6, past

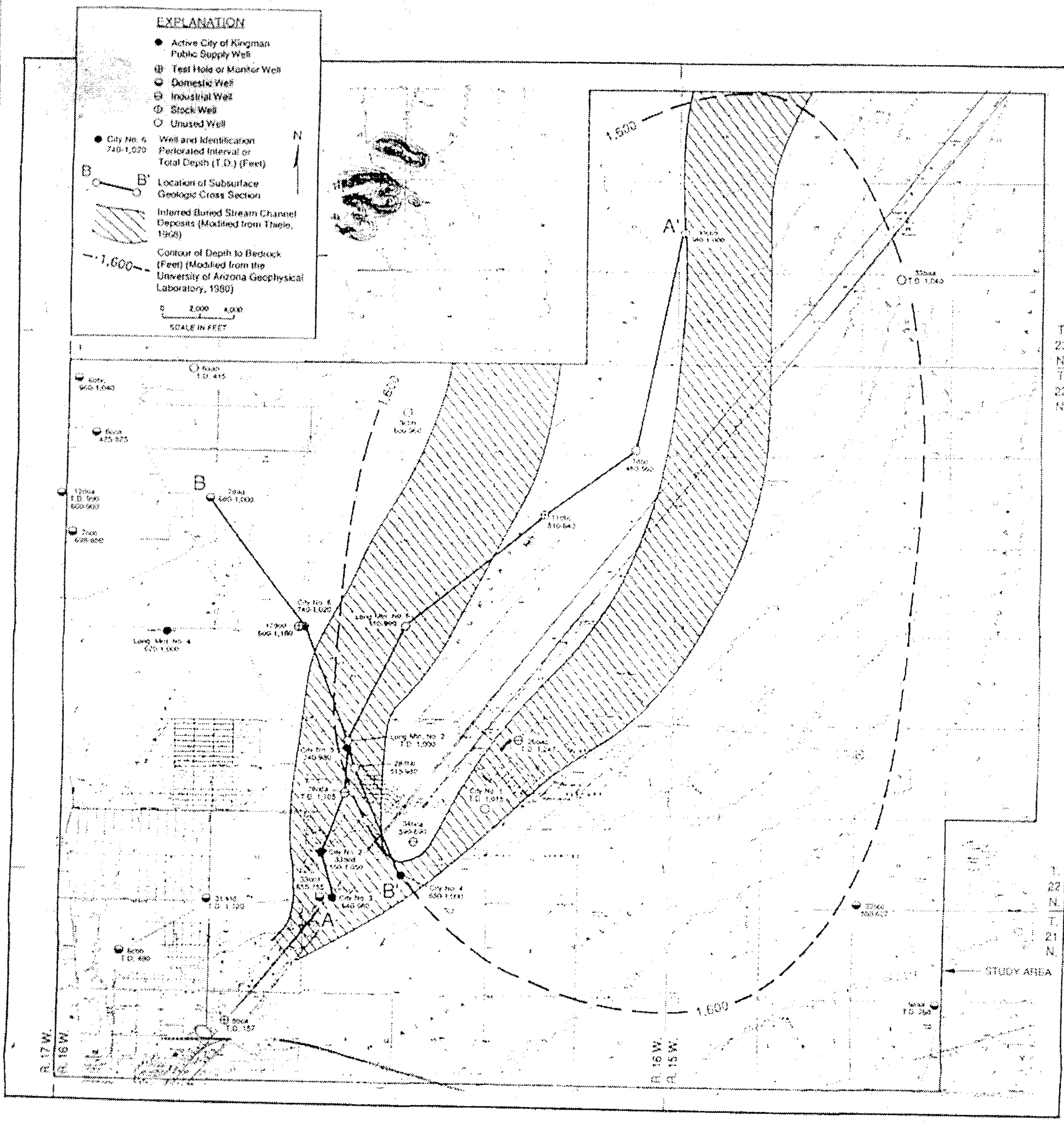

FIGURE 1 - LOCATION OF WELLS AND SUBSURFACE GEOLOGIC CROSS SECTIONS IN THE UPPER HUALAPAI VALLEY

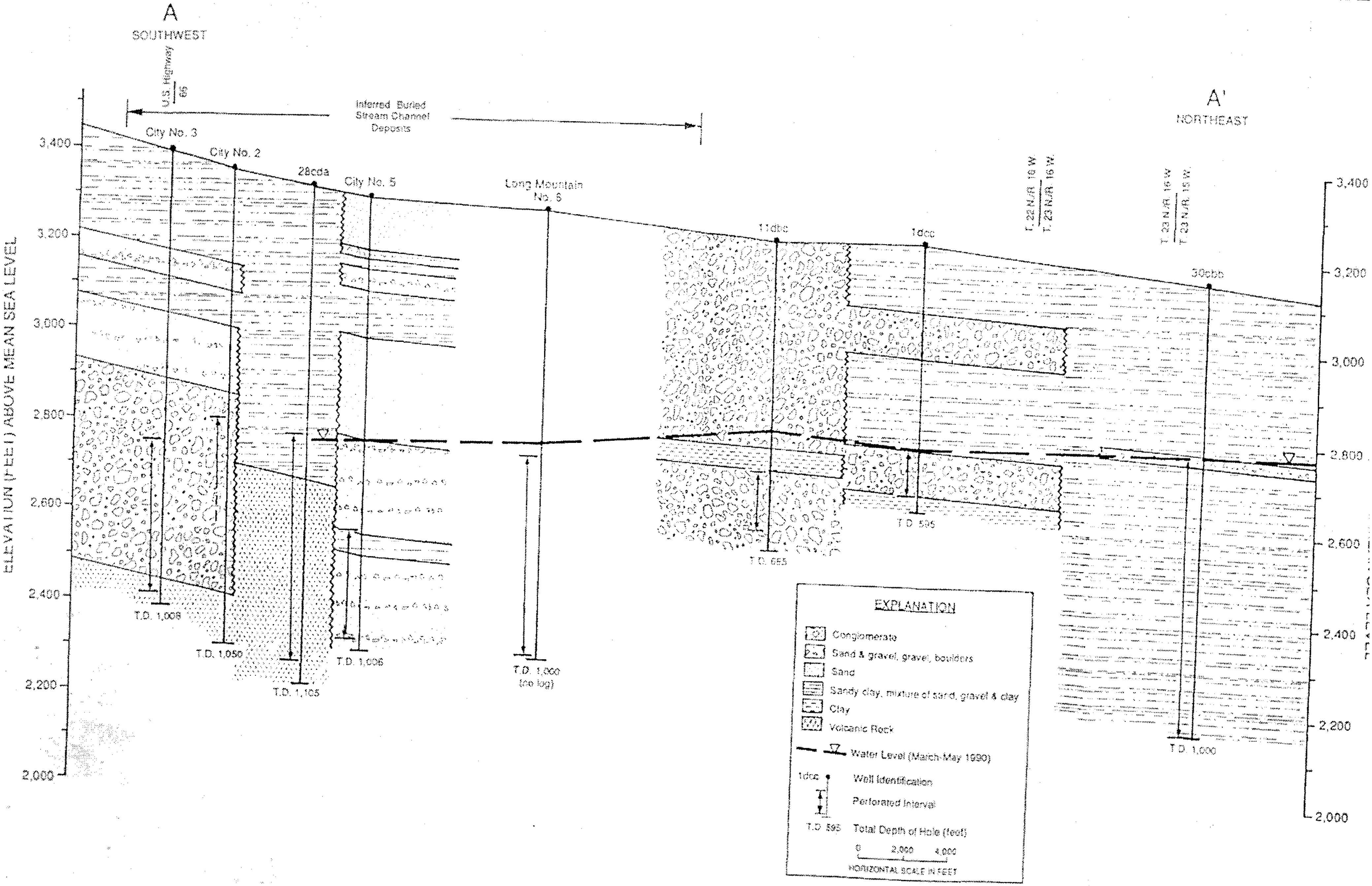

FIGURE 2 - SUBSURFACE GEOLOGIC CROSS SECTION A - A'

the Hill Top WWTP to Well (B-23-15)30cbb, which is located several miles south of Long Mountain. Wells along this section range in depth from about 600 to 1,000 feet. Three of these wells (City Well No. 2, 3, and 28cda) appeared to bottom in volcanic rock (basalt), and none are known to have bottomed in igneous intrusive or metamorphic rocks. The water level in January-February, 1991 is shown where measurements are available. Depth to water was about 540 feet at that time in City Well No. 5, and about 520 feet in Long Mountain Well No. 6.

Coarse-grained deposits (sand, gravel, or conglomerate) predominate in the alluvial deposits below the water table along this section. However, fine-grained deposits (silt or clay) appear to become more prevalent to the northeast, particularly at Well (B-23-15)30cbb. This part of the section is primarily between the two inferred buried stream channels that were mapped by Thiele (1968). There was a lack of information on conditions below a depth of about 600 feet along this section between Long Mountain Well No. 6 and Well 30cbb. Existing information indicates that some wells along the southwest part of this section bottomed in coarse-grained deposits, and deeper productive wells are considered possible (i.e., greater than 1,000 feet in depth).

Cross Section B-B' (Figure 3) extends from the northwest at Well (B-22-16)7daa through City Wells No. 6, and 5 to City Well No. 4 to the southeast. This section trends almost perpendicular to the inferred channel deposits. Depths of wells along this section are 1,000 feet, except for Well No. 6, which was drilled to a depth of 1,200 feet. Well 7daa apparently bottomed in granitic rock,

whereas the other wells apparently bottomed in alluvial deposits. Well 7daa also encountered about 220 feet of volcanic rocks overlying the granitic rock and beneath the alluvium. Depth to water in January-February, 1991 was about 580 feet in City Well No. 6 and 640 feet in City Well No. 4. The alluvial deposits at Well 7daa were thus estimated to be above the water table, and the production from that well is thus primarily from volcanic rock. Coarse-grained deposits predominated below the water table along the rest of this section, and there was a trend for more fine-grained deposits toward the southeast (Wells 28dbb and City Well No. 4). However, this section also indicates that wells deeper than 1,000 feet are possible, particularly along the central part of this section.

Well Construction Data

Table 1 summarizes construction data for City public-supply wells in the study area. Depths of these wells range from 1,000 to 1,050 feet, although a test hole was drilled to a depth of 1,200 feet near City Well No. 6. As discussed previously City Wells No. 2, 3, 4, and 5 and Long Mountain Well No. 6 were drilled at or near locations recommended by Thiele (1968). Cella Barr Associates (1991) reported on the results of the last City well that was drilled (City Well No. 6). Substantial hydrogeologic information is available for this well, compared to the earlier wells. Well No. 6 was drilled at a site slightly westerly of the general area recommended for City well development by Thiele (1968). The results indicated that the favorable production area of Thiele extends somewhat farther to the west than he projected.

TABLE 1 - CONSTRUCTION DATA FOR CITY OF KINGMAN PUBLIC-SUPPLY WELLS IN UPPER HUALAPAI VALLEY

Location	Local No.	Date Drilled	Depth Drilled (feet)	Casing Diameter (inches)	Cased Depth (feet)	Perforated Interval (feet)
(B-22-16)15ccc	Long Mountain No. 6	02/01/70	1,000	20	505	
				16	1,000	550-990
17ddd	City Well No. 6	06/27/91	1,040	18	1,040	740-1,020
19baa	Long Mountain No. 4	1965	1,000	16	1,000	620-1,000
28bda	City Well No. 5	12/03/82	1,006	18	980	740-980
33bcd	City Well No. 2	01/03/71	1,050	16	-	550- -
33cdc	City Well No. 3	01/71	1,008	16	1,008	640-990
34cbc	City Well No. 4	04/05/78	1,000	16	1,000	650-1,000

Data from drillers logs, City of Kingman records, Cella Barr Associates (1991), ADWR Groundwater Site Inventory of April 6, 1992, and ADEQ Public-Water Supply System and Well Inventory of January 28, 1991.

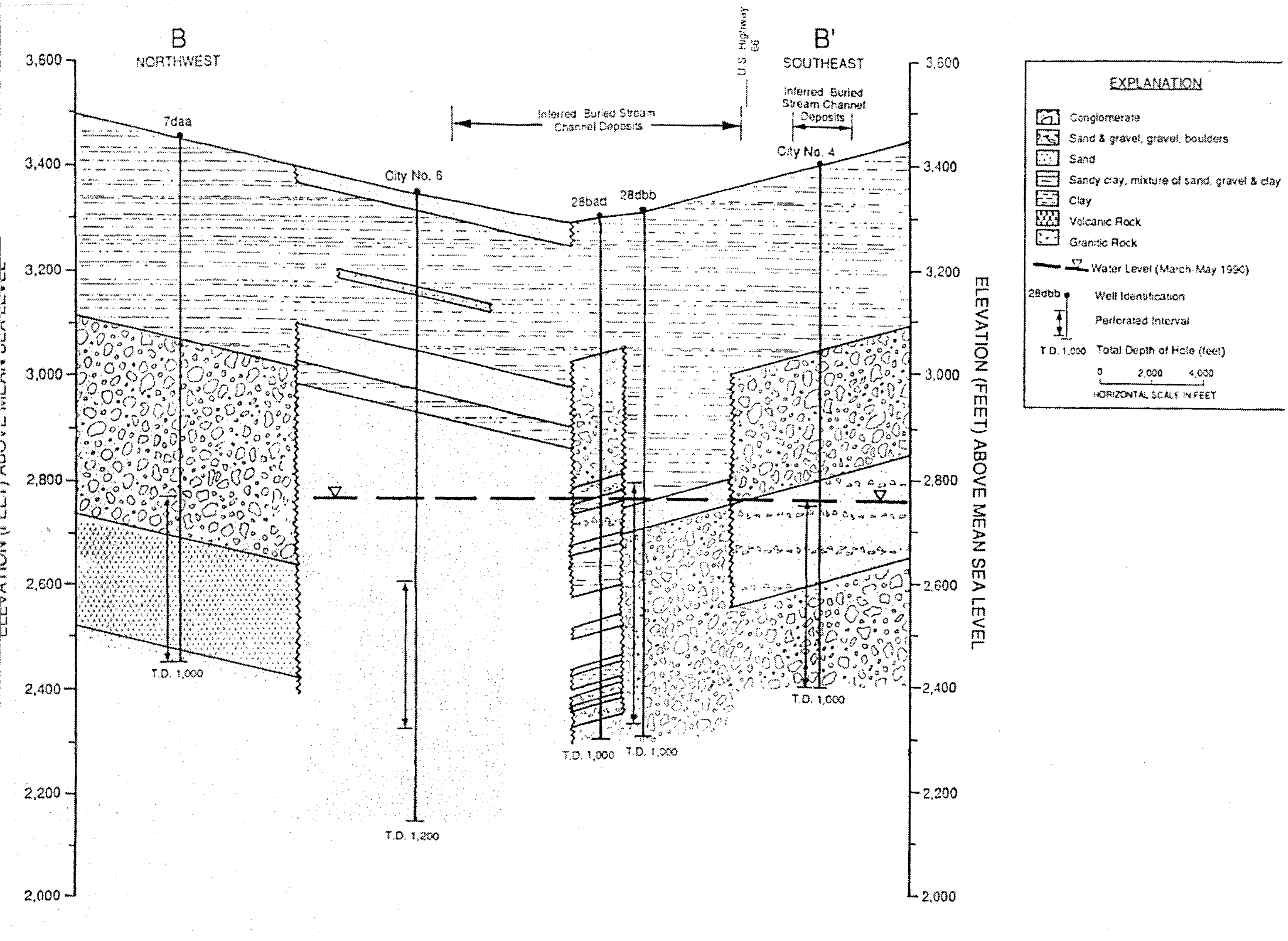

FIGURE 3 - SUBSURFACE GEOLOGIC CROSS SECTION B - B'

Water Levels

Gillespie and Bentley (1971, Plate 1) presented a map of the Hualapai Valley showing water-level elevations for Spring 1967. Water-level elevations in wells tapping alluvial deposits in the upper Hualapai Valley ranged from about 2,700 to 2,800 feet above mean sea level, and decreased to the northeast. This map indicated a northeasterly direction of groundwater flow, from the airport vicinity to near Hackberry, where groundwater flowed into the lower part of the Hualapai Valley. Remick (1981) presented water-level data for the Upper Hualapai Valley in 1980. Depth to water ranged from about 460 to more than 670 feet at that time, and generally increased to the northwest and southeast, away from Highway 66. Depth to water in most of the wells in T22N/R16W ranged from about 460 to 620 feet in 1980. Water-level elevations ranged from 2,718 to 2,786 feet above mean sea level and decreased to the northeast in the study area.

Figure 4 shows depth to water and water-level elevations in the study area in January-February, 1991. These water-level data were obtained from an Arizona Department of Water Resources computer printout of April 6, 1992. Depth to water beneath the part of the study area in T23N ranged from 361 to 451 feet at that time. For most of the rest of the study area, depth to water ranged from 419 to 695 feet, and increased to the west and southwest. Depth to water in most wells at or near the airport ranged from 520 to 640 feet at that time. Depth to water in two wells in the southeastern part of the study area ranged from about 870 to 920 feet in January-February 1991. Water level elevations ranged from 2,760 feet

above mean sea level southwest of the airport, to 2,724 feet east of Long Mountain. The direction of groundwater flow was to the northeast, and the average water-level slope was about four feet per mile.

Water-Level Hydrographs

Water-level hydrographs were prepared for five wells in the study area which have been frequently measured (Figure 5). Two of these are City wells (No. 4 and Long Mountain No. 6). The longest record available is for Well (B-22-16)28bad, which is 1,000 feet deep and located about two miles west of the airport, near City Well No. 5. Depth to water in this well fell from 508 feet in March 1963 to 538 feet in January 1991, or at an average decline of 1.1 feet per year. The next longest record is for Long Mountain Well No. 6, which is perforated from 550 to 990 feet in depth and located about three miles northwest of the airport. Depth to water in this well was apparently relatively constant during 1970-80, but declined from 498 feet in March 1980 to 520 feet in January 1991, or an average of 2.0 feet per year. The rate of water-level decline decreased in this well after 1984, when its use was stopped, to about 1.0 foot per year.

Well (B-22-16)3cbb is perforated from 600 to 960 feet in depth and is located about 2.5 miles north of Long Mountain Well No. 6. Depth to water in this well fell from 540 feet in November 1973 to 553 feet in October 1991, or an average of 1.6 feet per year. Depth to water in City Well No. 4 fell from 620 feet in April 1978 to 642 feet in January 1991, or an average of 1.7 feet per year.

This well is perforated from 650 to 1,000 feet in depth, and it is located about a mile and a half southwest of the airport.

Well (B-22-16)27ddd is 1,015 feet deep and is located near the southwest edge of the airport. Depth to water in this well fell from 602 feet in January 1986 to 608 feet in February 1992, or an average of 1.0 foot per year. Water-level declines in Upper Hualapai Valley have thus ranged from about one to two feet per year, depending largely on the proximity to active wells.

Aquifer Characteristics

Table 2 provides information on pumping rates and specific capacities for large-capacity wells in the study area. Pumping rates for most of the wells have ranged from about 400 to 2,400 gpm. For City wells, the pumping rates have ranged from about 500 to 2,400 gpm. Specific capacities ranged from 11 to 55 gpm per foot and were highest for City Well No. 5 and Well (B-22-16)7daa, which apparently primarily taps volcanic rock. Values for aquifer transmissivity have been determined from pump tests on two wells. A value of 105,000 gpd per foot was obtained for corrected recovery measurements in the nearby observation well for a two-day test conducted on City Well No. 6 (Cella Barr Associates, 1991). A value of 44,000 gpd per foot was obtained for Well (B-22-16)26bac (Gillespie and Bentley, 1971).

Gillespie and Bentley (1971) estimated that the average specific yield of the alluvium tapped by wells in the Hualapai Valley was from 5 to 10 percent. However, considering the average amount of City pumping of about 4,600 acre-feet per year from the upper

TABLE 2 - PRODUCTION DATA FOR SELECTED LARGE-CAPACITY WELLS IN THE UPPER HUALAPAI VALLEY

Location	Local No.	Date	Pumping Rate (gpm)	Static Level (feet)	Pumping Level (feet)	Drawdown (Feet)	Specific Capacity (gpm/ft)
(B-22-16) 7daa	-	2/78	387	670	677	7	55
15ccc	Long Mountain No. 6	6/70	2,430	501	725	224	11
17ddd	City No. 6	7/91	2,230	585	735	150	15
19baa	Long Mountain No. 4	1965	700	620	640	20	35
26bac	-	-	660	530	581	51	13
28bad	Long Mountain No. 2	3/63	500	508	530	22	23
28bda	City No. 5	1/83	2,400	531	575	44	55
33bcd	City No. 2	7/84	980	588	650	62	16
33cdc	City No. 3	9/71	1,900	612	725	113	17
34cbc	City No. 4						
(B-23-16)15bca	-	-	550	545	565	20	28

Data from City of Kingman records, Thiele (1968), Gillespie and Bentley (1971), Cella Barr Associates (1991), and ADWR well completion reports.

part of the valley, the resulting average water-level decline of about 1.5 feet per year, and the estimated area of influence (about 25,000 acres), the estimated specific yield is about 12 to 15 percent in the vicinity of the City well field.

City Pumpage

According to City records, City pumpage from alluvial deposits in the Upper Hualapai Valley since 1985 has averaged about 4,600 acre-feet per year. About eighty percent of this water has been produced from City Wells No. 2, 3, 4, and 5, west of the airport, and the remainder from Long Mountain Well No. 4, several miles to the northwest.

Recharge and Discharge

Natural recharge in most desert basins of the southwest is small, primarily due to the low annual precipitation. Gillespie and Bentley (1971) stated that most of the natural recharge in Hualapai Valley was from infiltration of streamflow. They estimated that an average of only several thousand acre-feet per year of streamflow entered the entire Hualapai Valley. Under natural conditions, the groundwater recharge was approximately equal to the subsurface outflow. Subsurface outflow from the entire Hualapai Valley was estimated by Gillespie and Bentley (1971) to average about 5,000 acre-feet per year. Remick (1981) recalculated this outflow, based on much more subsurface geologic information that was available, at only about half of the amount. For the upper part of the valley, the average annual natural groundwater recharge

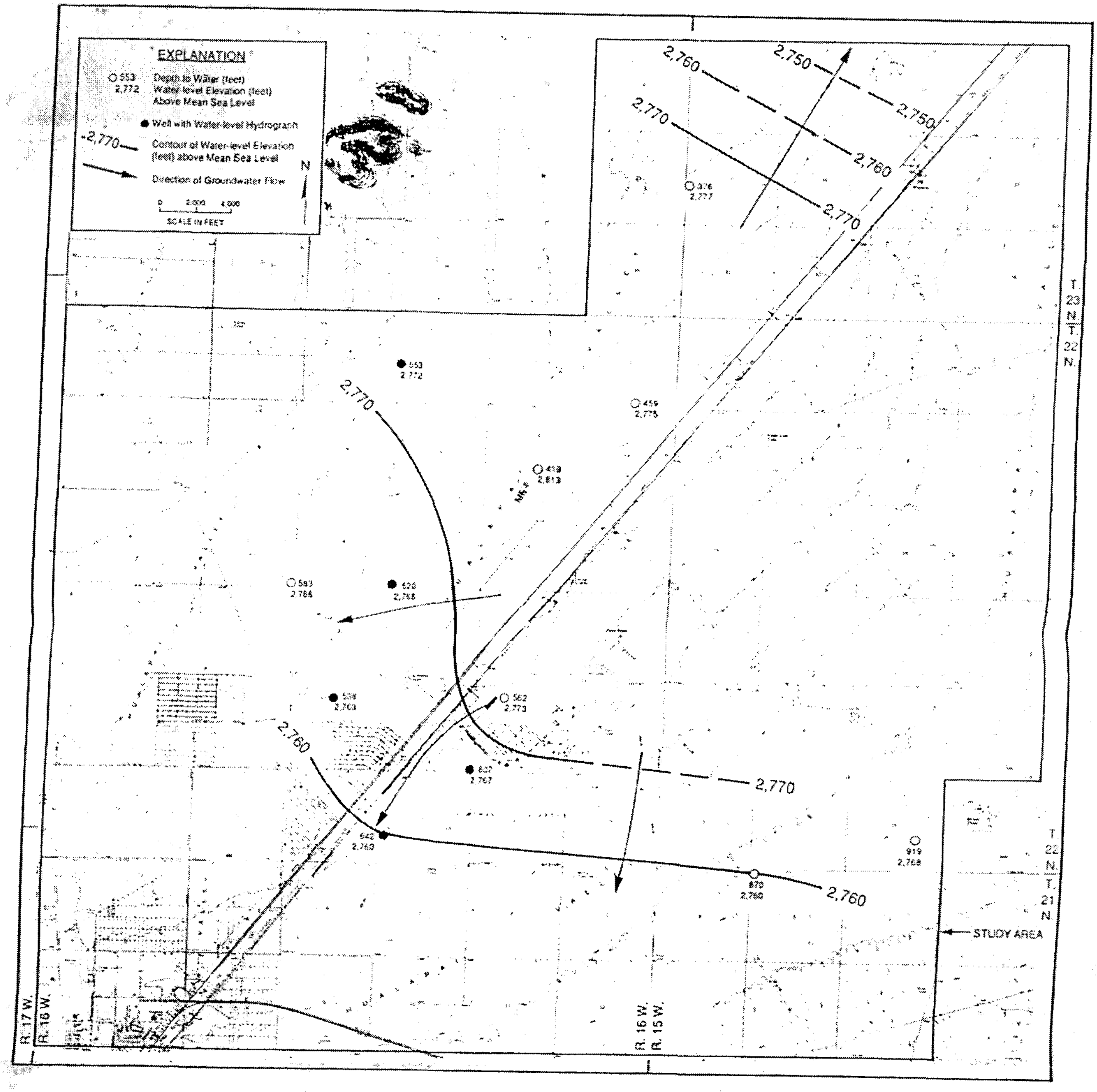

FIGURE 4 - WATER-LEVEL ELEVATIONS IN THE UPPER HUALAPAI VALLEY IN JANUARY-FEBRUARY 1991

is estimated to be only about 1,000 acre-feet per year. Groundwater discharge is primarily from pumping and groundwater outflow. Non-City pumpage in the upper part of the valley has not been precisely determined, but is estimated to average about 400 acre-feet per year. Total pumpage is thus estimated to average about 5,000 acre-feet per year. About one-fifth of this pumpage is estimated to return to the groundwater, such as from percolation of sewage effluent. There is an estimated 1,000 acre-feet of groundwater outflow from the Upper Hualapai Valley under present conditions. The net overdraft in the Upper Hualapai Valley is estimated to average about 4,000 acre-feet per year at present.

Amount of Groundwater in Storage

The amount of groundwater in storage above a depth of 2,000 feet in the study area was estimated. This depth is approximately the maximum expected water well drilling depth in the foreseeable future. Storage estimates were made for the alluvium both above a depth of 1,000 feet and below a depth of 1,000 feet. This is because much of the groundwater above a depth of 1,000 feet is believed to be of suitable inorganic chemical quality as to not require treatment prior to use for public supply (discussed in the following section of the report). The 1991 water-level depths were used for this evaluation, and an average specific yield of 12 percent was used for the saturated alluvial deposits above a depth of 1,000 feet. The average depth to water in this area was 600 feet, and there were approximately 46,000 acres of alluvium within the area where depth to bedrock was at least 1,000 feet. Multiplying this area and specific yield times the average saturated thickness of 400 feet yields an amount of groundwater in storage of about 2,200,000 acre-feet.

For the depth interval from 1,000 to 2,000 feet, there were an estimated 38,000 acres of saturated alluvium in the study area. Because the deeper deposits are generally finer grained, a lower specific yield (8 percent) was used than for the over-lying deposits. Multiplying this area by the specific yield and a saturated thickness of 1,000 feet yields an amount of groundwater in storage of about 3,000,000 acre-feet. About two-thirds of this is considered recoverable with large-capacity wells. Much of this deeper water could require treatment for removal of chromium, fluoride, arsenic and possibly other constituents prior to use for public supply. Combining these two amounts, there was an estimated 5,200,000 acre-feet of groundwater in storage (about 4,200,000 acre-feet of which is recoverable) above a depth of 2,000 feet in the study area in 1991. At the present rate of over-drafting, this water could last for about 1,100 years.

Groundwater Quality

Gillespie and Bentley (1971) indicated that the inorganic chemical quality of the groundwater in the Upper Hualapai Valley was generally good as of the 1960's, except for some mineralized water in and near some parts of the Hualapai and Cerbat Mountains. The general trend observed in Hualapai Valley was an increase in total dissolved solids (TDS) content with downgradient flow and a change from a sodium-calcium bicarbonate water type in the upper part of the valley to a sodium chloride type near Red Lake.

Robertson (1991) described changes in groundwater quality with downgradient flow in a number of similar alluvial basins in western Arizona. He evaluated high contents of fluoride, chromium, arsenic, barium, and selenium in many of these basins and attributed these occurrences to natural (geochemical) processes.

Table 3 summarizes the results of chemical analyses of water from wells in the study area. Except for two earlier analyses, these are for samples collected during 1990-92. TDS contents ranged from about 220 to 570 mg/l. Except for Well (B-22-16)7daa, which primarily tapped volcanic rock, TDS contents ranged from about 220 to 420 mg/l. The water was primarily of the sodium-calcium bicarbonate type. Nitrate contents ranged from 6 to 12 mg/l, except for Well (B-22-16)11dbc, which is a shallow monitor well at the Hill Top WWTP, which had water with a nitrate content of 38 mg/l. Nitrate contents in this report are expressed as nitrate. To obtain nitrate-nitrogen contents, nitrate contents are divided by 4.4. All of the nitrate contents were less than the maximum contaminant level (MCL) of 45 mg/l (equivalent to 10 mg/l of nitrate-nitrogen). Fluoride contents ranged from 0.4 to 1.7 mg/l, less than the present MCL of 4.0 mg/l. Fluoride contents were highest in water from City Wells No. 2, 3, and 4, located southwest of the airport. The only trace metal in the Primary Drinking Water Standards that is known to have been present exceeding an MCL in groundwater in the study area is chromium. Chromium contents in water from wells ranged from less than 0.01 to 0.098 mg/l. Contents equal to or exceeding the present state MCL

TABLE 3 - CONTENTS OF INORGANIC CHEMICAL CONSTITUENTS IN WATER FROM WELLS IN THE UPPER HUALAPAI VALLEY (B-22-16)

Constituent (mg/l)	7daa	11dbc	15ccc Long Mtn No. 6	17ddd City No. 6	19baa Long Mtn No. 4
Calcium	71	53	23	15	50
Magnesium	42	34	17	31	31
Sodium	43	90	37	27	38
Carbonate	0	0	0	0	0
Bicarbonate	139	281	171	217	159
Sulfate	160	56	14	9	80
Chloride	130	110	20	24	76
Nitrate	7	38	9	6	8
Fluoride	0.5	0.4	0.9	0.7	0.7
pH	7.5	-	7.8	7.8	7.7
Total Dissolved Solids	574	-	250	270	420
Iron	0.04	<0.1	<0.1	0.07	<0.1
Manganese	-	<0.05	<0.05	<0.01	<0.05
Arsenic	0.001	<0.01	<0.01	<0.005	<0.01
Barium	0.03	<0.5	<0.5	<0.1	<0.5
Cadmium	-	<0.005	<0.005	<0.005	<0.005
Chromium	0.01	<0.01	0.05	0.094	0.02
Lead	<0.1	<0.005	<0.002	<0.01	<0.002
Mercury	-	<0.001	<0.001	<0.001	<0.001
Selenium	-	<0.005	<0.005	<0.005	<0.005
Silver	-	<0.02	<0.02	<0.01	<0.02
Date	9/1/82	2/19/91	2/24/92	7/31/91	3/30/90
Perforated Interval (feet)	-	510-640	550-990	740-1,020	620-1,000
Laboratory	USGS	ATL	ATL	Lab Cons.	ATL

Continued:

TABLE 3 - CONTENTS OF INORGANIC CHEMICAL CONSTITUENTS IN WATER FROM WELLS IN THE UPPER HUALAPAI VALLEY (B-22-16) (CONTINUED)

Constituent (mg/l)	27ddd	28bda City No. 5	33bcd City No. 2	33cdc City No. 3	34cbc City No. 4
Calcium	-	27	20	17	19
Magnesium	-	18	18	16	16
Sodium	-	31	33	33	30
Carbonate	-	0	0	0	0
Bicarbonate	-	183	171	159	159
Sulfate	-	16	16	20	16
Chloride	-	24	22	22	22
Nitrate	-	12	11	8	9
Fluoride	-	1.0	1.5	1.7	1.7
pH	7.8	7.8	8.0	7.8	8.0
Total Dissolved Solids	-	270	230	220	230
Iron	-	<0.1	<0.1	<0.1	<0.1
Manganese	-	<0.05	<0.05	<0.05	<0.05
Arsenic	-	<0.01	<0.01	<0.01	<0.01
Barium	-	<0.5	<0.5	<0.5	<0.5
Cadmium	-	<0.005	<0.005	<0.005	<0.005
Chromium	0.098	0.04	0.07	0.07	0.07
Lead	-	<0.002	<0.002	<0.002	<0.002
Mercury	-	<0.001	<0.001	<0.001	<0.001
Selenium	-	<0.005	<0.005	<0.005	<0.005
Silver	-	<0.02	<0.02	<0.02	<0.02
Date	5/24/83	3/30/90	3/30/90	3/30/90	3/30/90
Perforated Interval (feet)	T.D. 970	740-980	550-1,050	640-990	650-1,000
Laboratory	USGS	ATL	ATL	ATL	ATL

[5] Data from City of Kingman records and U.S. Geological Survey printout of multiple station analyses of November 13, 1992.

of 0.05 mg/l were present in water from Long Mountain Well No. 6, City Well No. 2, 3, 4, and 6, and Well (B-22-16)27ddd. The highest chromium contents (0.094 to 0.098 mg/l) were found in water from City Well No. 6 and Well (B-22-16)27ddd.

The U.S. Environmental Protection Agency raised the federal MCL for chromium from 0.05 to 0.10 mg/l effective July 30, 1992. The Arizona Department of Environmental Quality on June 18, 1992 granted the City of Kingman an exclusion from the state MCL for chromium, pending revision of the state MCL to comply with the new federal MCL. Thus all of the sample results are below the new MCL for chromium.

However, chromium is still considered an important constituent because water from four City wells had chromium contents of 0.07 mg/l or greater, and water from two wells had chromium contents greater than 0.09 mg/l. Little information is available on the vertical distribution of chromium in the groundwater in the study area. An exception is for the observation well (B-22-16)17ddd that was constructed prior to drilling City Well No. 6. After this well was completed and perforated from 600 to 1,180 feet in depth, water samples were collected from various depths (Cella Barr Associates, 1991). Because of a lack of appropriate sampling techniques used for this sampling, only relative trends can be determined. This is primarily because of the drilling method used, the small hole diameter, which did not allow proper placement of a gravel pack or annular seals to separate groundwater in various depth intervals, and a lack of obtaining and analyzing sediment-free water samples, which is essential. Two trends that are apparent were lower chromium contents above a depth of about 850 feet, which agrees with the low chromium content in water from Well (B-22-16)11dbc at the Hill Top WWTP. This well is only 640 feet deep. The other apparent trend was an increase in chromium below a depth of about 1,000 feet. These are not unusual trends for groundwater in alluvial deposits at other sites in Arizona, such as in the Salt River Valley. In the future, it would be advisable to drill a pilot hole by the reverse rotary method at perspective sites for new supply wells and to use long-developed, proven sampling techniques to delineate the vertical variations in groundwater quality.

Potential Areas for Groundwater Development

Plate 1 of Thiele's 1968 report shows the locations of the main water-producing strata (inferred to be buried stream channel deposits) in the Upper Hualapai Valley, based on electric resistivity soundings. City Wells No. 2, 3, 5, and Long Mountain Wells No. 2 and 6 were drilled in the area of his western inferred buried stream channel. City Well No. 6 was drilled about a quarter of a mile west of this inferred channel. City Well is No. 4 is in the eastern inferred buried stream channel. Thiele projected these channels to extend all of the way to the north end of the study area. The results of drilling have confirmed Thiele's projections; that is, high-yielding wells have been developed at the locations he recommended. Available land ownership maps indicate that there are large tracts of private land overlying both of these inferred channel deposits. Lands very far to the east of these channel deposits are apparently underlain by deep water levels (usually 700 to more than 900 feet deep). Some lands west of the inferred channel deposits may also be favorable for groundwater development (Sections 19, 20, 29, and 30). Records are available for only one deep well, (B-16-23)30cbb, in the area between the inferred channel deposits. The drillers log for this well indicates finer-grained deposits than have been encountered within the inferred channels. The preponderance of available data indicates that the most favorable hydrogeologic areas for future groundwater development are in or near the inferred stream channel deposits.

Storage Space Available for Recharge

The amount of storage space in the alluvial deposits above the water table in the study area was estimated. Because these deposits are generally coarser-grained than the deposits that are below the water table, an average specific yield of 15 percent was used. In addition, it was assumed that water levels would not be raised above a depth of 50 feet below the land surface due to recharge. Using an estimated area of alluvium of 62,000 acres, an average saturated thickness of 550 feet, and this specific yield, there was an estimated storage space above the water table of about 5,100,000 acre-feet in the study area in 1991. Thus in terms of storage space, the Upper Hualapai Valley has considerable potential for groundwater storage. The average rate of groundwater flow with the present hydraulic gradient is estimated to be less than 30 feet per information on deeper subsurface geologic conditions in this part of the area is from geophysical surveys.

Subsurface Geology

The rocks outcropping in the mountains bounding Golden Valley are intrusive igneous and metamorphic rocks in the Cerbat Mountains to the north and east. Volcanic rocks crop out in the Black Mountains to the west and the southern end of the Cerbat Mountains on the southeast. These volcanic rocks include basalt flows, basaltic andesite flows, rhyolite and rhyolite tuffs.

Gillespie and Bentley (1971, Plate 2) reported on an east-west seismic survey that was done through the middle of T20N. This survey indicated that the alluvium was more than 4,000 feet thick along parts of this survey line. Oppenheimer and Sumner (1980) presented the results of two gravity profiles that were run in Golden Valley north of the previously referenced seismic survey and the results of gravity modeling. Profile 10-2 extended from west to east near state Highway 68, north of the study area for this evaluation. Profile 10-3 also extended from east to west, near the southern boundary of T21N. Interpretation of the results of these surveys and gravity modeling allowed preparation of a depth to bedrock map. This map indicates that bedrock is more than 3,200 feet deep beneath the central part of Golden Valley, and becomes considerably shallower within several miles of the mountain fronts. For purposes of this evaluation, areas underlain by bedrock deeper than about 1,600 feet are considered more favorable for groundwater development, and are delineated in Figure 6.

As part of this evaluation, two subsurface geologic sections were developed (Figure 6). Cross Section A-A' (Figure 7) is oriented from the northwest to southeast and extends from near the north boundary of the study south to near the south boundary of T21N. Cross Section D-D' (Figure 8) is oriented from the southwest to the northeast, and extends from the west edge of the study area to near the northeast corner.

Depths of wells along Cross Section C-C' range from about 1,350 to 1,500 feet. Coarse-grained deposits (sand, gravel, or conglomerate) predominate except near the base of this section. The lower part of the coarse-grained deposits is often conglomerate. Fine-grained deposits (clay or silt) appear to be predominant below a depth ranging from about 1,200 to 1,300 feet along this section. None of the wells along this section encountered bedrock, which is as expected, based on the results of the geophysical studies. Depth to water ranged from about 940 to 1,030 feet along the northern (topographically higher) part of the section and ranged from about 750 to 800 feet along the southern (topographically lower) part of the section in Spring 1990.

Depths of wells along Cross Section D-D' range from about 1,230 to 1,410 feet. Coarse-grained deposits also predominate along this section. Volcanic rock was encountered at a depth of about 1,200 feet at Well (B-21-19)25bbb. Several basalt layers were encountered at Well (B-21-18)10ccc. The lower part of the coarse-grained deposits along this section also appears to be conglomerate, which was the major water-producing deposit tapped by the wells. Fine-grained strata also predominate at depth along most of this section, at similar depths to those previously described for Section C-C'. Depth to water in Spring 1990 ranged from about 850 to 900 feet beneath the western part of this section to almost 1,000 feet beneath the northeast corner (topographically higher).

Well Construction Data

Most wells in the study area are of two types. Large-capacity wells (primarily for public supply and mining) in the north part of the study area are about 1,200 to 1,370 feet deep and are perforated over from about 200 to 400 feet of alluvial deposits, often conglomerate. Small-capacity domestic wells in the south part of the study area are often shallower (about 670 to 820 feet deep) and perforated over an interval from 60 to 90 feet thick.

Water Levels

Gillespie and Bentley (1971) presented water-level elevations in Golden Valley for Spring 1967. Water-level elevations ranged from an estimated 1,720 feet above mean sea near the south boundary of the study area to about 1,790 feet near the north boundary. The direction of groundwater flow was indicated to be to the south-southeast at that time. Pfaff and Clay (1981) indicated that depth to water ranged from about 740 to 910 feet in the study area in 1979. The water-level elevation ranged from about 1,710 feet above mean sea level near the south boundary to about 1,770 feet near the north boundary. The direction of groundwater flow was southerly beneath most of the study area at that time.

Figure 9 shows water-level data for Spring 1991. A noticeable cone of depression was present beneath the southwest part of T21N/R18W at that time, and water-level elevations ranged from about 1,745 to 1,770 feet above mean sea level in this depression. This depression appeared to be associated with pumping for public-supply and mining. Depth to water in the T21N part of the study area ranged from about 760 feet beneath topographically low areas (i.e., near Cerbat Wash) to 950 feet near the northwest corner of the study area. In the south part of the study area, depth to water has ranged from about 570 to 700 feet in recent years, and the deeper levels were beneath the topographically higher areas.

Water-Level Changes

Water-level hydrographs were prepared for two wells in or near the study area. Well (B-20-18)22aca in 800 feet deep and is located in the southern part of the study area. Water-level measurements are available for this well since 1964. Depth to water has declined from about 738 feet in Spring 1964 to 745 feet in early 1992, or a decline of about 0.25 foot per year. This is probably due to a small amount of pumping in the area. Water-level measurements are available for Well (B-21-18)21bcc, perforated from 900 to 962 feet in depth. Measurements for 1983-91 indicate no overall change in depth to water during this period.

Measurements are available for five wells in or near the Duval well field in the north part of the study area for 1964 and 1990. Based on these measurements, water-level declines in these wells ranged from 0.5 to 1.1 and averaged 0.8 feet per year. These are believed to be representative of water-level declines in the Cyprus (formerly referred to as Duval) well field vicinity. There has been little or no water-level decline in the rest of the study area, based on available records.

Well Production and Aquifer Characteristics

Table 4 provides information on pumping rates and specific capacities for seven large-capacity wells in the study area. Pumping rates for these wells ranged from about 700 to 1,000 gpm. Specific capacities ranged from 8 to 32 gpm per foot and were less than 20 gpm per foot except for one well.

Values for aquifer transmissivity are available for four of the wells listed in Table 1. Following is a summary of the values obtained:

Well Location	Transmissivity (gpd per foot)
(B-20-18) 4bbb	46,000
(B-21-18)32dcc	35,000
(B-21-19)13ddd	17,000
(B-21-19)25bbb	36,000

TABLE 4 - PRODUCTION DATA FOR LARGE-CAPACITY WELLS IN GOLDEN VALLEY

Location	Local No.	Date	Pumping Rate (gpm)	Static Level (feet)	Pumping Level (feet)	Drawdown (Feet)	Specific Capacity (gpm/ft)
(B-20-18) 4bbb	Cyprus No. 5	-	670	734	806	72	9
(B-21-18)20caa	Cyprus No. 4	-	910	910	966	56	16
30abb	Cyprus No. 2	4/63	1,050	886	919	33	32
32bbb	Cyprus No. 3	6/63	1,100	820	911	91	12
32dcc	Cyprus No. 1	-	725	747	843	96	8
(B-21-19)13ddd	GVID No. 1	4/91	690	921	995	74	9
25bbb	GVID No. 2	7/91	700	866	904	38	18

Data from Gillespie and Bentley (1971) and Manera, Inc. (1991).

Gillespie and Bentley (1971) provided the results for the tests on the first two wells. Manera, Inc. (1991) provided values for the tests on the last two wells, based on 72-hour aquifer tests. The average of these values is about 36,000 gpd per foot. Gillespie and Bentley (1971) estimated the storage coefficient in Sacramento Valley to range from 5 to 10 percent for the alluvial deposits.

Pumpage

Pfaff and Clay (1981) estimated that there was an average of about 6,200 acre-feet per year of groundwater pumped from the entire Sacramento Valley during 1965-78. In 1978, the estimated pumpage was 8,000 acre-feet. Most of this pumping was from the Cyprus well field. Rascona (1991) estimated that only about 1,000 acre-feet of groundwater were pumped in the study area in 1989.

Groundwater Quality

Gillespie and Bentley (1971) discussed regional groundwater quality in the Sacramento Valley. High TDS groundwater is locally present along the west side of the Cerbat Mountains. The salinity of the groundwater is much lower elsewhere. The average TDS content of groundwater in the alluvium was about 350 mg/l. Table 5 contains the results of inorganic chemical analyses of water from wells in Golden Valley. Most of the analyses are for water samples collected during 1989-91. TDS contents ranged from about 240 to 420 mg/l and the waters were of the sodium or sodium-calcium bicarbonate type. Nitrate contents ranged from 7 to 15 mg/l, well

TABLE 5 - CONTENTS OF INORGANIC CHEMICAL CONSTITUENTS IN WATER FROM WELLS IN GOLDEN VALLEY

Constituent (mg/l)	(B-20-18)		(B-21-18)		
	4bbb	33adc	5dbd	8bbb	9bba
Calcium	29	15	26	32	37
Magnesium	13	13	10	15	15
Sodium	49	37	55	85	79
Potassium	7	7	8	-	-
Carbonate	0	0	0	0	0
Bicarbonate	146	171	133	115	99
Sulfate	50	14	75	174	138
Chloride	40	18	42	53	61
Nitrate	15	12	7	9	13
Fluoride	0.6	0.6	0.6	0.6	0.4
Boron	0.1	0.1	0.2	-	-
pH	7.6	8.0	8.0	7.3	7.4
Electrical Conductivity (micromhos/cm @ 25°C)	540	375	550	-	-
Total Dissolved Solids	321	243	339	420	420
Iron	<0.01	0.005	0.02	7.8	<0.01
Manganese	0.001	<0.001	0.002	0.13	<0.05
Arsenic	0.007	<0.001	-	<0.005	<0.02
Barium	0.004	0.004	-	<0.1	<0.1
Cadmium	<0.001	<0.001	-	<0.005	<0.005
Chromium	0.034	0.009	0.042	0.012	0.018
Lead	<0.01	<0.001	-	<0.01	<0.02
Selenium	0.002	-	-	<0.001	<0.001
Silver	-	-	-	0.01	<0.02
Temperature (°F)	100	90	100	100	97
Date	9/3/80	8/8/90	5/1/90	12/18/91	8/19/85
Laboratory	USGS	USGS	USGS	ATL	ATL
Perforated Interval (feet)	1,000-1,300	T.D. 695	1,028-1,350	1,006-1,216	1,040-1,273

Continued:

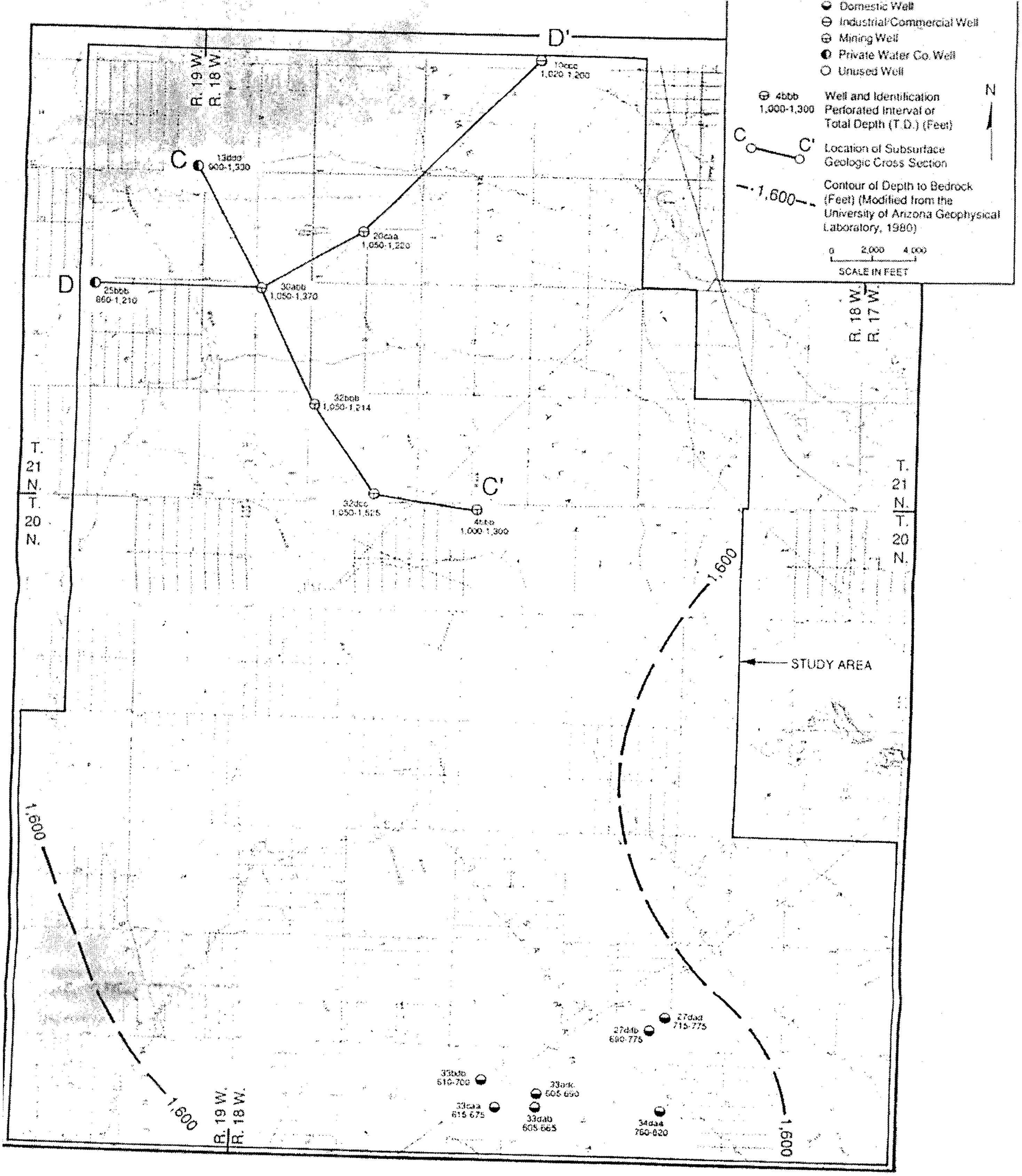

FIGURE 6 - LOCATION OF WELLS AND SUBSURFACE GEOLOGIC CROSS SECTIONS IN THE GOLDEN VALLEY

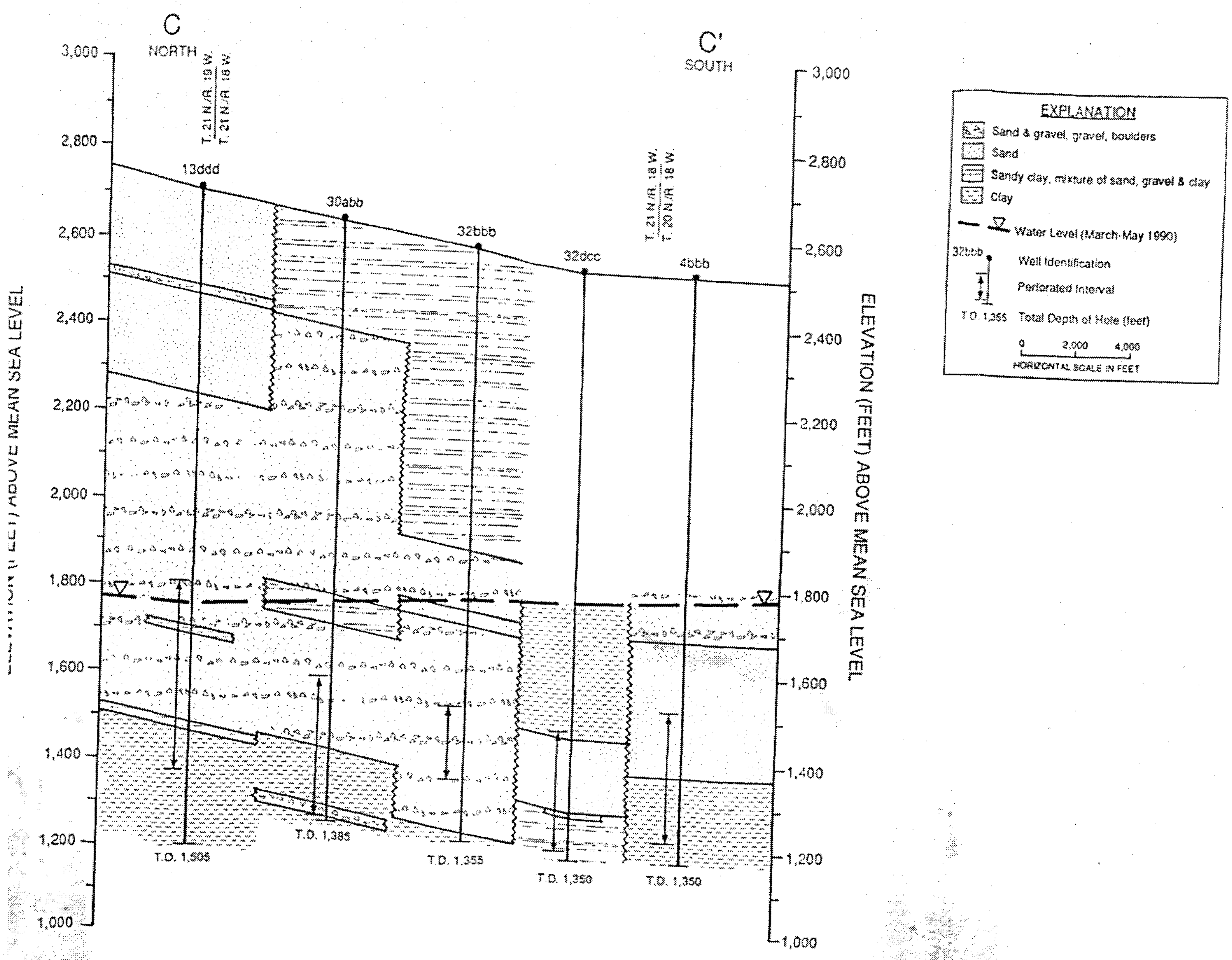

FIGURE 7 - SUBSURFACE GEOLOGIC CROSS SECTION C - C'

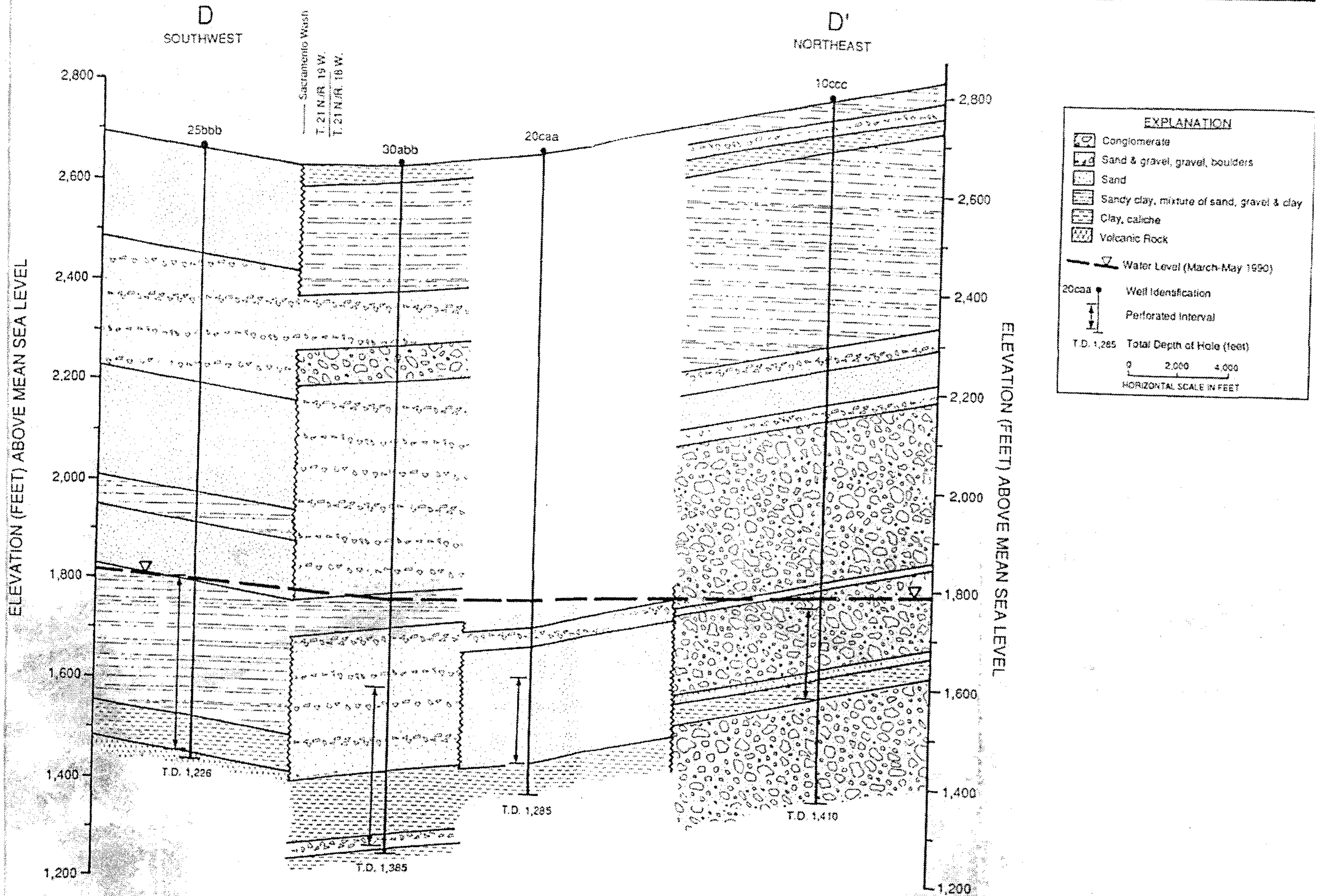

FIGURE 8 - SUBSURFACE GEOLOGIC CROSS SECTION D - D'

TABLE 5 - CONTENTS OF INORGANIC CHEMICAL CONSTITUENTS IN WATER FROM WELLS IN GOLDEN VALLEY
(Continued)

Constituent (mg/l)	(B-21-18)		(B-21-19)		
	30abb	32bbb	2ddd	13ddd	25bbb
Calcium	30	31	26	24	17
Magnesium	11	13	11	11	7
Sodium	38	37	31	43	62
Potassium	8	10	10	-	-
Carbonate	0	0	0	0	0
Bicarbonate	168	146	170	171	183
Sulfate	25	42	14	20	25
Chloride	24	32	17	26	30
Nitrate	11	11	12	12	9
Fluoride	0.8	0.8	0.7	0.7	1.4
Boron	0.2	0.1	0.1	-	-
pH	7.8	7.6	7.9	7.8	7.8
Electrical Conductivity (micromhos/cm @ 25°C)	430	480	380	-	-
Total Dissolved Solids	293	310	280	250	280
Iron	0.01	<0.01	0.006	<0.1	0.3
Manganese	0.002	0.002	0.001	<0.05	<0.05
Arsenic	0.01	0.007	0.007	<0.01	0.012
Barium	0.005	0.004	<0.002	<0.5	<0.5
Cadmium	<0.001	0.002	<0.001	<0.005	<0.005
Chromium	0.008	0.018	0.002	<0.01	<0.01
Lead	0.004	0.017	0.002	0.006	<0.002
Mercury	-	-	-	<0.001	<0.001
Selenium	-	0.001	-	<0.005	<0.005
Silver	-	-	-	<0.02	<0.02
Temperature (°F)	100	100	103	-	-
Date	7/20/89	9/3/80	7/19/91	4/15/91	6/8/91
Laboratory	USGS	USGS	USGS	ATL	ATL
Perforated Interval (feet)	1,050-1,370	1,050-1,214	T.D. 1,251	900-1,330	860-1,210

Analyses from Mohave County Health Department and U.S. Geological Survey printout of Nov. 13, 1992.

below the MCL of 45 mg/l (equivalent to 10 mg/l of nitrate-nitrogen. Nitrate contents in this report are expressed as nitrate. To obtain nitrate-nitrogen contents, these values can be divided by 4.4. Fluoride contents ranged from 0.4 to 0.8 mg/l, except for one well. The fluoride content in water from Well (B-21-19)25bbb was 1.4 mg/l. All of these fluoride contents were below the present MCL of 4.0 mg/l. Contents of all metals in the Primary Drinking Water Standards were less than the respective MCLs. Chromium contents were less than 0.02 mg/l except in water from two wells. Water from Well (B-21-18)5dbd had a chromium content of 0.042 mg/l and water from Well (B-20-18)4bbb had a chromium content of 0.034 mg/l. The inorganic chemical quality of groundwater in Golden Valley appears suitable for public supply. Relatively hot water (100 to 103°F) was produced from at least six of these wells.

Potential Area for Groundwater Development

The eastern part of the study area in T20N/R18W is considered the most favorable hydrogeologic area for possible development of water for public supply. Included are lands in Sections 2, 3, 4, 9, 10, 11, 14, 15, 16, 21, 22, 23, 24, 25, and 36. The inorganic chemical quality of the groundwater in this area is likely suitable for public supply. Water-level elevations in this part of Golden Valley are projected to range from 1,750 to 1,770 feet above mean sea level, compared to above 2,750 feet in Upper Hualapai Valley near the airport. One of the greatest constraints to developing the groundwater in this area is the low water-level elevation compared to that of the City service area and the water-level elevations in Upper Hualapai Valley. Thus farther consideration of Sacramento Valley does not appear to be warranted at this time.

SUMMARY AND CONCLUSIONS

Although recharge to the groundwater in the Upper Hualapai Valley and Golden Valley is relatively small, there are large amounts of groundwater in storage in both of the valleys. Although most existing wells in the Upper Hualapai Valley are not more than 1,000 feet deep, deeper wells are possible. Well depths up to 2,000 feet deep should be considered. Water levels in Upper Hualapai Valley have been declining from about one to two feet per year in recent decades. The present overdraft in the Upper Hualapai Valley is estimated to be about 4,000 acre-feet per year. There is an estimated 2.2 million acre-feet of groundwater in storage in this valley above a depth of 1,000 feet. Much of this water is believed to be of suitable quality so as to not require treatment prior to use for public supply. Chromium contents in water for some City wells have exceeded the MCL of 0.05 mg/l. However, the new EPA MCL for chromium has been raised to 0.10 mg/l. Water from the City wells has had chromium contents below this revised MCL. An additional 2.0 million acre-feet of groundwater below a depth of 1,000 feet in the valley is considered recoverable. However, much of this deeper water could require treatment for removal of some chemical constituents prior to use for public supply. The most favorable hydrogeologic areas for future groundwater development are in or near inferred buried stream channel deposits, as previously reported by Thiele (1968). Because of relatively deep water levels, the Upper Hualapai Valley has considerable potential for storage of imported water. There was space above the water table in 1991 for more than 5 million acre-feet of water.

In Golden Valley, a number of wells are from 1200 to 1500 feet deep. In 1991, depth to water ranged from about 600 to more than 900 feet deep, and generally increased to the north. Water-level declines have averaged about one foot per year in recent decades in or near the Cyprus well field, and elsewhere little change is apparent. The quality of most of the groundwater in Golden Valley is believed to be suitable for public supply. The most hydrogeologically favorable area for development of groundwater for public supply is in T20N/R18W. However, water-level elevations in this area are almost 1,000 feet lower than in Upper Hualapai Valley near the airport. The Upper Hualapai Valley is a more hydrogeologically favorable area for development of groundwater for the City of Kingman.

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WELL DATA

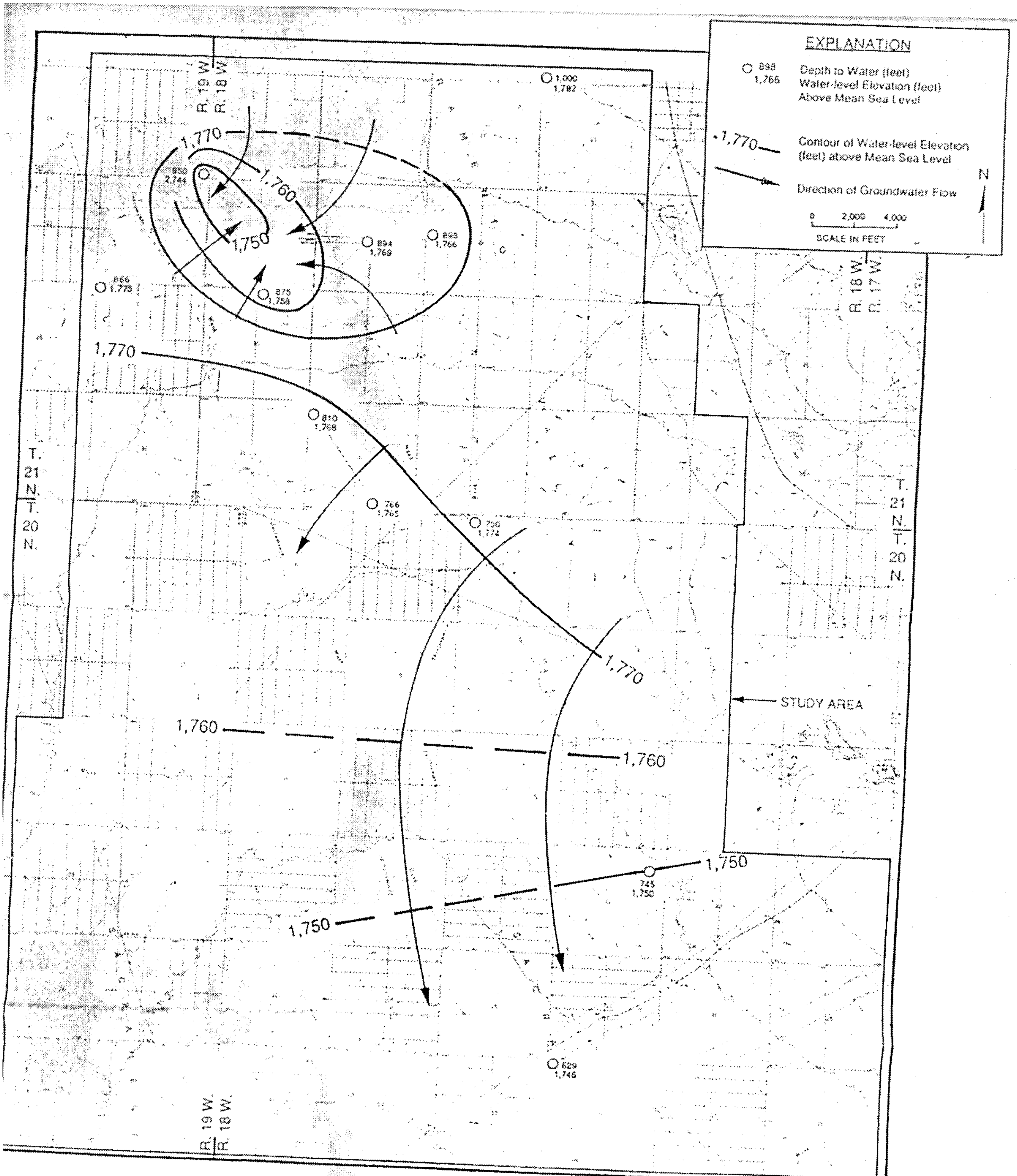

FIGURE 9 - WATER-LEVEL ELEVATIONS IN THE GOLDEN VALLEY IN 1990-91

TOWNSHIP	RANGE	SECTION	QTR 1	QTR 2	QTR 3	WELL REGISTRATION	WELL OWNER	WELL DEPTH	WATER LEVEL	S IZE CASING	YIELD GPM	REGISTRATION DATE	WATER USE	WELL TYPE
21	16	6	C	B	B	617205	LINGENFELTER, J.G.	480	310	8	10	2/01/77	AD	E
21	16	8	B			523919	GROUNDWATER TECH INC	25	10	4	0	3/14/89	N	Z
21	16	6	C	B	B	617205	LINGENFELTER	480	310	8	10	2/01/77	AD	E
21	16	8	B			523919	GROUNDWATER TECH INC	25	10	4	0	3/24/89	N	Z
21	16	8	B	C	A	502658	HUSKY OIL CO.	157	9999	8		4/27/82	N	E
21	16	13	D			535905	TRANSWESTERN PIPELINE	9999	9999			7/07/92	N	Z
21	16	17	D	C	D	506113	FLEMING	595	450	4	10	8/15/83	D	E
21	16	20	C			649986	GOOD	385	385	12	25	6/14/82	J	E
21	16	20	C	A	C	802007	GOOD	785	400	12	100	2/12/85	A	N
21	16	20	C	D	A	501464	ROUNSEVILLE	505	410	8	16	1/01/81	D	E
21	16	20	C	D	C	641533	ROPER	480	430	8	25	1/01/65	D	E
21	16	20	C	D	D	501459	STREDDE	490	415	6	15	9/28/82	A	N
21	16	20	C	D	D	501423	LACKEY	490	415		14	11/05/81	A	N
21	16	23	B	A	A	631357	WEST WING ASSOC.	690	560	6	2	12/01/54	J	E
21	16	24	B	D	C	631345	BLM	86	60	6	3	1/01/49	J	E
21	16	24	B	D	D	631347	BLM	20	18			1/01/52	J	E
21	16	24	C	D	A	631346	BLM	85	70	8	2	1/01/49	J	E
21	16	26	B	D	D	516208	GLOBE CORPORATION	300	9999	8		12/08/86	J	E
21	16	28	B	C	D	528814	THORNTON	800	580	7	0	9/07/90	D	E
21	16	28	C	A	A	526138	SCRITTER	660	525	5	12	10/11/89	D	E
21	16	28	C	A	A	508589	EL PASO NATURAL GAS CO	606	9999	6	0	8/08/84	N	Z
21	16	29	B	B	A	530843	SHORT, TOM & JIM	665	400	7	21	2/16/91	F	E
21	16	29	B	B	A	631344	WEST WING ASSOC	490	230	8	8	2/01/57	J	E
21	16	34	A	B	C	525068	DUNTON	545	200	5	0	11/06/89	DJ	N
21	16	35	A	A	A	631341	BLM	46	60	6	3	1/01/68	J	E
21	16	35	C	C	C	531342	BLM	154	40	8	4	11/01/61	J	E
21	16	35	C	C	C	631343	BLM	90	40	6	3	11/01/61	J	E
21	17	1	A	A	C	512747	SHORT	260	210	7	0	3/14/86	D	E
21	17	1	A	B	B	514962	BRACKETT	235	180	7	0	12/08/86	D	E
21	17	1	B	B	A	508753	SHUFFLER	330	270	4	0	1/09/85	D	E
21	17	1	B	C	C	531622	LANGLOIS	200	85	7	10	7/31/91	D	E
21	17	1	B	D	A	520161	HUNTER	330	280	7	10	2/17/88	D	E
21	17	1	C	B	A	506350	DUNTON	680	215	7	4	2/24/84	D	E
21	17	1	C	B	C	612660	CITY OF KINGMAN	525	142	8	120	6/04/82	E	N
21	17	1	D	B	C	602069	LARSON	350	240	8	26	1/01/77	D	E
21	17	1	D	D	D	526516	GLASS	268	187	6	30	11/17/89	D	E
21	17	3	C	D	A	612654	CITY OF KINGMAN	350	65	8	125	6/04/82	E	N
21	17	10	D			608680	SHORT	100	20	8	35	4/01/73	DJ	N
21	17	10	D	D	B	87764	PENROD	160	35	5	25	5/10/82	D	E
21	17	10	D	D	C	515810	ISAACS	200	90	7	17	12/20/86	D	E
21	17	10	D	D	D	505702	DILDINE	160	60	7	15	8/30/83	D	E
21	17	11	C	C	A	508602	BOATMAN	150	50	7	5	9/07/84	D	E
21	17	11	C	C	C	641401	WINTERS	100	50	4	15	11/05/79	D	E
21	17	11	C	D		623346	HOPKINS	135	30			2/09/82	D	E
21	17	11	D	C	A	626202	IDSINGA	120	9999		0	6/14/82	DJ	N
21	17	11	D	C	A	626203	IDSINGA	160	9999		0	6/14/82	DJ	N
21	17	12	A	A		608953	COFER	350	200	10	60	1/01/70	AD	N
21	17	12	B	B	B	511006	WATKINS	230	150	7	12	6/20/85	D	E
21	17	13	B	B	B	508462	MCKINNIE	235	180	7	10	8/06/84	D	E
21	17	13				637022	LOGAN	265	50	6	7	7/02/67	D	E
21	17	13	B	D	B	512902	SCHRITTER	460	260	7	25	4/10/86	D	E

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TOWNSHIP	RANGE	SECTION	QTR 1	QTR 2	QTR 3	WELL REGISTRATION	WELL OWNER	WELL DEPTH	WATER LEVEL	SIZE CASING	YIELD GPM	REGISTRATION DATE	WATER USE	WELL TYPE
21	17	14				630500	WATSON	9999	9999		0	3/09/82	J	E
21	17	14	A	D	B	631824	PAUP	220	135	6	5	4/20/71	D	E
21	17	14	B			622674	WATSON	200	50	8	5	1/01/66	D	E
21	17	14	B			647569	BONHAM	160	100	6	12	3/01/64	D	E
21	17	14	B			646846	DOLLARHIDE	125	6	8	30	1/01/05	A	E
21	17	14	B			646847	DOLLARHIDE	150	18	8	30	3/01/62	D	E
21	17	14	B			647847	DOLLARHIDE	150	12	8	30	9/01/66	D	E
21	17	14	B	A	A	520814	HOLLYOAK	223	17	5	0	1/17/89	D	E
21	17	14	B	A	B	601708	BOND	160	30	6	35	1/30/80	D	E
21	17	14	B	A	B	531176	FINCH	105	35	7	0	7/31/91	DA	E
21	17	14	B	A	C	620992	LEONARD	150	125	8	50	1/01/65	D	E
21	17	14	B	B	A	******	FINCH	115	45	8	0	1/01/65	D	E
21	17	14	B	C	C	647756	WARE	20	7	7	30	1/01/20	AD	E
21	17	14	B	C	C	647757	WARE	100	15	6	7	3/01/78	DA	E
21	17	14	B	D	B	502576	SMITH	180	65	6	7	4/23/82	D	E
21	17	14	B	D	D	502486	HOLYOAK	180	40	6	8	4/07/82	D	N
21	17	14	B	D	D	800238	WALKER	180	9999	8	10	7/23/82	D	E
21	17	14	B	D	D	527506	HOLYOAK	320	280	7	0	2/01/91	D	E
21	17	14	C	B	D	530244	COLLINS	240	64	7	15	2/01/91	DA	E
21	17	14	C	C	B	648618	CAUGHLIN	250	19	8	0	1/01/64	DA	E
21	17	14	C	C	B	643663	COVINGTON	100	12	8	30	12/03/67	DA	E
21	17	14	C	C	B	643662	COVINGTON	30	14	4	15	12/02/75	DA	E
21	17	14	D	B	B	637558	RETHA	165	160		5	1/01/69	D	E
21	17	14	D	B	B	637559	RETHA	130	120		5	1/01/70	D	E
21	17	14	D	B	C	642860	LABLO	200	60	6	10	5/01/75	D	E
21	17	14	D	C	B	510716	CHERRY	160	30	5	7	4/08/84	D	E
21	17	15	A	C	C	506877	ABBOTT	340	70	4	0	1/12/84	D	E
21	17	15	A	C	C	506878	ABBOTT	100	40	4	0	1/19/84	D	N
21	17	15	B	C	C	612653	CITY OF KINGMAN	200	35	8	30	6/04/82	E	N
21	17	23				630560	BRUNS	175	132	10	0	3/12/84	D	E
21	17	23				646222	CAMPBELL	160	9999	8	0	1/01/40	D	E
21	17	23	A	B	B	641980	LONG	240	105	12	13	6/01/56	D	E
21	17	23	A	B	C	611638	VANCE	240	180	8	10	12/21/82	A	E
21	17	23	A	C		643858	MORENO	9999	9999		0	6/03/82	A	E
21	17	23	A	D	A	506477	LINDLEY	205	170	4	1	10/22/83	D	E
21	17	23	A	D	B	644785	ARTHUR	250	140	8	10	1/01/58	D	E
21	17	23	A	D	B	637103	GROVER	250	231	2	10	6/11/82	D	E
21	17	23	A	D	C	637111	JOY	300	9999	8	0	6/01/30	D	E
21	17	23	A	D	D	621746	BLACK	120	120		10	1/01/25	D	E
21	17	23	B	B	B	602037	BARKHURST	300	245	10	10	1/01/76	D	E
21	17	23	B	B	D	806347	HARVEY	9999	9999		0	12/31/62	D	E
21	17	23	B	C	D	629642	HIGH DESERT INC.	200	100	10	50	6/14/82	DF	N
21	17	23	D	D	A	625708	CITIZENS UTILITIES	500	113	10	220	1/01/20	EF	N
21	17	24				629194	SHELTON	9999	9999		0	6/17/82	D	N
21	17	24				645813	GRAVES	390	9999		0	1/01/16	D	E
21	17	24				643974	PALUMBO	9999	9999		0	5/20/82	D	E
21	17	24				650186	KAUSE	175	100	8	5	6/14/82	D	E
21	17	24				649360	TEMPLEMAN	9999	9999		0	6/14/82	D	E
21	17	24				649361	TEMPLEMAN	9999	9999		0	6/14/82	D	E
21	17	24				636984	HOPEMAN	265	90	8	15	1/01/50	D	E
21	17	24				621772	OLIVER	100	85	4	0	12/17/81	A	E
21	17	24				609958	DUNTON	0	0	0	0	6/01/70	D	N

TOWNSHIP	RANGE	SECTION	QTR 1	QTR 2	QTR 3	WELL REGISTRATION	WELL OWNER	WELL DEPTH	WATER LEVEL	S IZE CASING	YIELD GPM	REGISTRATION DATE	WATER USE	WELL TYPE
21	17	24	B	C	C	631417	BRAZIE	300	180	6	10	12/28/78	D	E
21	17	24	C	B	C	612663	CITY OF KINGMAN	195	119	10	120	6/04/82	E	N
21	17	24	C	C	A	642012	HAMMOND	200	170	8	0	1/01/30	D	E
21	17	24	C	D	A	627231	ATCHISON-TOPEKA	178	9999	12	0	4/28/17	EF	N
21	17	24	C	D	B	627230	ATCHISON-TOPEKA	232	9999	12	0	9/20/12	EF	N
21	17	24	C	D	B	612661	CITY OF KINGMAN	232	149	10	170	1/01/12	E	N
21	17	24	C	D	C	644784	ARTHUR	145	120	8	6	1/01/09	D	E
21	17	24	C	D	D	612662	CITY OF KINGMAN	235	118	10	230	6/04/82	E	N
21	17	25				604877	BENNETT	0	0	0	0	1/20/82	D	N
21	17	25	A	A	B	650973	ASBUR	9999	9999	8	0	1/01/30	AD	E
21	17	25	A	A	C	650400	LAMP	212	9999		0	7/14/82	A	E
21	17	25	A	B	B	642010	BULET	100	80	6	10	1/01/30	D	E
21	17	25	B	A		620649	ZUMWALT	300	60	6	30	1/01/48	DA	E
21	17	34				646882	BUTLER	88	66	6	12	1/01/54	D	E
21	17	34				647653	STARR BLOCK CO.	9999	9999		0	6/14/82	AD	E
21	17	34				606273	WMK TRANSIT MIX	105	70	10	25	8/05/77	F	E
21	17	34	A	C	D	650406	NIEMEYER	170	9999	5	11	1/01/62	D	E
21	17	34	B	B		801624	BLM	9999	9999	4	0	1/01/67	J	E
21	17	34	D	C	A	601845	MEDLIN	100	60	8	500	6/01/60	DJ	N
21	17	34	D	C	C	644117	KEPNER	100	40	6	20	2/01/63	D	E
21	17	35	B	B	C	632770	CUNNINGHAM	106	75	10	15	11/01/45	D	E
21	17	35	B	B	C	632771	CUNNINGHAM	175	95	8	0	11/23/77	D	E
21	17	35	B	B	C	632772	CUNNINGHAM	175	75	6	31	9/30/77	D	E
21	17	35	B	B	C	632773	CUNNINGHAM	175	75	6	0	10/14/77	D	E
21	17	35	C			644646	LEWIS	92	62	8	29	4/01/52	D	E
22	16	15	C	C	C	612657	CITY OF KINGMAN	1000	500	16	1650	10/10/74	E	N
22	16	17	D	D	D	529815	CITY OF KINGMAN	1200	650	8	0	2/06/91	M	X
22	16	17	D	D	D	529816	CITY OF KINGMAN	1040	580	30	0	6/27/91	E	N
22	16	19	B	A	A	612658	CITY OF KINGMAN	1002	652	16	500	1/01/72	E	N
22	16	26				605484	GENERAL CABLE CO.	1235	546	0	800	2/12/67	F	N
22	16	27	D	D	D	612667	CITY OF KINGMAN	1015	590	14	700	3/28/68	E	N
22	16	28	B	A	D	612659	CITY OF KINGMAN	1000	560	10	450	1/01/63	E	N
22	16	28	B	D	A	504272	CITY OF KINGMAN	1006	531	18	2400	12/03/82	E	N
22	16	28	C	D	A	502501	CITY OF KINGMAN	1105	524	2	0	4/11/82	M	E
22	16	31	A	C	D	643039	PROSSER	800	664	8	15	11/01/78	D	E
22	16	33	B	C	D	612666	CITY OF KINGMAN	1040	60	16	900	1/01/68	E	N
22	16	33	C	C	D	530645	BROWN DRILLING	795	670	8	0	1/27/92	D	E
22	16	33	C	D	C	612665	CITY OF KINGMAN	1008	612	16	1200	8/01/71	E	N
22	16	34	B	C	A	500156	DESERT CONST. INC	700	575	9	100	7/20/81	F	N
22	16	34	C	B	C	612664	CITY OF KINGMAN	1000	590	16	1050	4/05/78	E	N
22	17	14	A	A	C	536469	SAYLES	9999	9999		0	8/24/92	D	E
22	17	14	A	A	D	536470	SAYLES	9999	9999		0	8/24/92	D	E
22	17	14	A	B	C	536471	SAYLES	9999	9999		0	8/24/92	D	E
22	17	14	A	C		506961	SHUFFLER	120	60	4	0	2/20/84	D	E
22	17	14	B	A	D	518157	NEAL	180	107	6	0	12/01/87	D	N
22	17	14	B	B	B	518156	NEAL	189	87	6	0	12/10/87	D	N
22	17	14	B	B	D	518155	NEAL	240	87	6	0	12/05/87	D	N
22	17	14	B	C	A	522902	JACKSON	175	100	7	0	1/25/89	D	E
22	17	14	B	C	C	504681	BARRETT	145	75	7	0	1/20/83	D	E
22	17	14	B	C	D	504680	BARRETT	115	60	7	0	1/22/83	D	E
22	17	14	B	D		85466	RICCARDI	175	100	4	10	1/01/80	D	E
22	17	14	B	D	A	509436	RASMUSSEN	300	132	7	0	10/16/84	D	E

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TSHIP	RANGE	SECTION	QTR 1	QTR 2	QTR 3	WELL REGISTRATION	WELL OWNER	WELL DEPTH	WATER LEVEL	SIZE CASING	YIELD GPM	REGISTRATION DATE	WATER USE	WELL TYPE
22	17	14	B	D	B	534915	TERLESKY	281	140	5	0	4/28/92	D	E
22	17	14	C	A	A	518888	HOLLEY	175	100	7	0	2/04/88	D	E
22	17	14	C	B	B	631627	BROOKS	255	9999	10	10	1/01/88	D	E
22	17	15	D	A	D	631625	BROOKS	65	35	8	0	1/01/18	J	E
22	17	15	D	A	B	517387	NEAL	400	16	6	0	11/04/87	D	N
22	17	15	D	A	B	517388	NEAL	207	12	6	0	11/07/87	D	N
22	17	15	D	A	B	517389	NEAL	175	15	6	0	11/13/87	D	N
22	17	15	D	A	B	517390	NEAL	170	10	7	0	11/19/87	D	N
22	17	15	D	B	A	508823	MCLAUGHLIN	115	50	7	0	8/20/84	D	E
22	17	15	D	B	C	531528	METZ	200	90	7	5	5/08/91	D	E
22	17	15	D	D	C	631626	BROOKS	165	9999	10	10	1/01/68	J	E
22	17	34	B	D	A	612656	CITY OF KINGMAN	102	25	8	90	6/04/82	E	N
22	17	34	D	C	A	606419	NEAL	30	10	6	35	1/01/30	J	E
22	17	34	D	C	D	612655	CITY OF KINGMAN	317	16	12	90	6/04/82	E	N